Research Article

Trajectories of Depressive Symptoms Experienced by Older People: Effects of Time, Hurricane Sandy, and the Great Recession

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Abstract

Objectives: To examine depressive symptom trajectories as a function of time and exposure to Hurricane Sandy, accounting for the effects of the Great Recession.

Methods: We analyzed 6 waves of data from a 12-year panel using latent class growth models and multinomial logistic regression.

Results: We identified 4 groups of people experiencing different trajectories of depressive symptoms. The groups differed on baseline characteristics (gender, age, education, income, race), history of diagnosed depression, and initial level of depressive symptoms. The group with the highest levels of depressive symptoms reported greater levels of peri-traumatic stress exposure to Hurricane Sandy.

Discussion: Depressive symptoms increased as a function of the Great Recession, but exposure to Hurricane Sandy was not associated with subsequent increases in depressive symptoms for any of the 4 groups. People who consistently experienced high levels of depressive symptoms over time reported the highest levels of peri-traumatic stress during Hurricane Sandy. Findings highlight the importance of accounting for historical trends when studying the effects of disaster, identify people likely to be at risk during a disaster, and provide novel information about the causal relationship between exposure to disaster and depressive symptoms.

Keywords: Disaster, History-graded events, Life course

Population-based studies consistently find that long-term naturalistic trajectories of depressive symptoms are heterogeneous across the life span, with most people experiencing few or no symptoms, a notable minority experiencing persistent symptoms, and the rest experiencing symptoms that come and go (Kuchibhatla et al., 2012; Lincoln & Takeuchi, 2010; Musliner et al., 2016). Depending on the age group studied, three to five distinct depressive

symptom trajectories are typically identified in samples of middle-aged and older people (Hsu & Jones, 2012; Lee & Park, 2018; Xiang & Cheng, 2019). A parallel line of research examining depressive symptom trajectories in the context of exposure to a disaster hints at a process of resilience whereby depressive symptoms increase just after the disaster and then return to pre-disaster levels (Lowe & Rhodes, 2013). However, most studies of disaster rely on

small, homogeneous, nonrepresentative samples (Galatzer-Levy et al., 2018). In both the population and disaster research, however, studies rarely account for the historical context in which depressive symptoms unfold. This limitation has the potential to result in misattribution of change in depressive symptoms to either developmental change or change due to the disaster when in reality the change may be due to a broader, macroeconomic source. The analyses that follow use data from a panel of older people collected since 2006, examining depressive symptom trajectories as a function of time and exposure to Hurricane Sandy, accounting for the effects of the Great Recession.

Trajectories of Depressive Symptoms Experienced by Older People

At any given time, 10%–15% of community-dwelling older people experience high levels of depressive symptoms (Blazer, 2003; Laborde-Lahoz et al., 2015; Mohebbi et al., 2019), which is concerning because depressive symptoms are associated with mortality (Cuijpers et al., 2014). Additionally, many older people experience subclinical levels of depressive symptoms that increase the risks for morbidity and mortality (Blazer, 2003). As a result, to understand the extent to which depressive symptoms experienced by older people can be assuaged or prevented, scholars have studied the course of depressive symptoms over time. These studies demonstrate that there is variability in the long-term trajectories of depressive symptoms, with most research identifying three to five trajectory groups with varying degrees of severity and stability (Andreescu et al., 2008; Byers et al., 2012; Kuchibhatla et al., 2012; Liang et al., 2011; Saeed Mirza et al., 2018). Exemplary of these studies is Xiang's (2020) analysis of 7,573 adults from the National Health and Aging Trends Study, which revealed a four-trajectory model, consisting of individuals who were "persistently low" (77.7%), "increasing" (7.9%), "declining" (5.5%), and "persistently high" (8.9%). Similar findings characterize international samples (Hsu & Jones, 2012; Lee & Park, 2018), supporting the idea that the long-term course of depressive symptoms in the general older population is heterogeneous.

Studies typically find that depressive symptom trajectory group membership is associated with individual-level characteristics including: age (Kuchibhatla et al., 2012; Saeed Mirza et al., 2018; Xiang, 2020), socioeconomic status (Kuchibhatla et al., 2012; Liang et al., 2011), race/ethnicity (Liang et al., 2011; Xiang, 2020), sex (Andreescu et al., 2008; Kuchibhatla et al., 2012; Saeed Mirza et al., 2018; Xiang, 2020), current smoking (Byers et al., 2012; Saeed Mirza et al., 2018), alcohol consumption (Saeed Mirza et al., 2018), physical health (Andreescu et al., 2008; Byers et al., 2012; Kuchibhatla et al., 2012; Liang et al., 2011; Saeed Mirza et al., 2018; Xiang, 2020), cognitive ability (Kuchibhatla et al., 2012; Xiang, 2020), and social connections (Byers et al., 2012; Kuchibhatla et al., 2012;

Xiang, 2020). However, little is known about how collective stressors and trauma experienced as a function of a disaster, such as Hurricane Sandy, affect depressive symptom trajectories, which is the unique contribution of the present analyses.

Trajectories of Depressive Symptoms in the Context of Disaster

Disasters are traumatic events that have the potential to simultaneously alter the lives of many people. Disasters can be caused by a natural event such as an earthquake or hurricane; they can be human-made, triggered by a terrorist act or the result of an accident or technological failure. Disasters can result from a combination of technology failure and operator error such as an airplane or train crash and disasters can be caused by epidemics and pandemics, such as COVID-19.

Research consistently finds an association between disasters and post-traumatic stress disorder (PTSD), with people experiencing higher levels of exposure having a greater likelihood of experiencing PTSD (Galea et al., 2005; North et al., 2004; Utzon-Frank et al., 2014). A recent analysis of data from low-income mothers interviewed once before Hurricane Katrina and three times after found that post-traumatic stress symptoms declined at each of the three post-Katrina follow-ups, but 12 years after the hurricane, one in six people still had symptoms indicative of probable PTSD (Raker et al., 2019). However, it is critical to understand the effects that disaster exposure has on other indicators of mental health beyond PTSD; studies examining the association between disaster exposure and depression are rare. A meta-analysis of cross-sectional studies by Tang et al. (2014) revealed that prevalence of depression ranged from 5.8% to 54.0% in adults exposed to natural disasters. However, most of this research included small samples, and most of the disasters studied were earthquakes. Additionally, the time between the disaster and assessment ranged from 1 month to 4 years.

Most longitudinal studies of disasters fail to include information about participants prior to the disaster, limiting conclusions about causality. Nandi et al. (2009), for example, analyzed trajectories of depression after the September 11, 2001 disaster. Similarly, Pietrzak et al. (2013) studied adults in Galveston Bay after Hurricane Ike struck. Pre-disaster data were lacking in both studies. In the absence of prospective data, it is impossible to discern whether post-disaster elevations in depressive symptoms stem from preexisting conditions or are the result of the disaster and its aftermath.

Studies that include information about people prior to the disaster have yielded inconclusive findings. Some studies find rapid resolution after exposure to mass trauma (North et al., 2004), others find persistent burden, with little evidence of recovery (Fullerton et al., 2004; Goenjian et al., 2005). Studies begun prior to a disaster

that were able to adjust data collection efforts and document the effects of the disaster are particularly important to our understanding about the effects of disasters. One such study built on a project designed to examine whether performance-based scholarships affected the academic achievement, health, and well-being of low-income parents (Richburg-Hayes et al., 2009). Investigators had collected data from 492 people living in New Orleans between 2004 and 2005, before Hurricanes Katrina and Rita caused havoc there in August and September 2005. Between May 2006 and March 2007, Lowe and Rhodes (2013) located and interviewed 81.7% of the participants from the original study about their experiences during and after the hurricane. Similarly, VanLandingham had initiated a study of first-generation Vietnamese American families living in New Orleans weeks before Hurricane Katrina struck. Follow-up waves were conducted 1, 2, and 5 years after Katrina (VanLandingham, 2017; Vu & VanLandingham, 2012). Analyzing data from a large sample of older people in New Jersey collected before and after Hurricane Sandy, Wilson-Genderson et al. (2018) found significant linear increases in depressive symptoms over time that were positively associated with a prior depression diagnosis, younger age, less education, lower income, and greater reports of peri-traumatic storm exposure. Only by charting depressive symptoms over time, measuring depressive symptoms multiple times before and after the event can the effects of events be understood.

Trajectories of Depression and History-Graded Events

Beyond time and disaster exposure, lives are embedded within a particular time and place. Elder demonstrated the profound influences that the Great Depression (1974), the declining rural Midwest economy (Elder & Conger, 2000), and the Great Recession (Bynner et al., 2017) had on the lives of young people. This work provided the basis for the life course perspective on aging, one of the preeminent theoretical orientations in the study of human development. According to the life course perspective, historical events (i.e., Great Depression, World War II, Korean and Vietnam wars) can have both immediate and long-range effects that differentially influence the life course of people depending on the age at which a person experiences the events (Elder, 2014; Schaie & Elder, 2005). Although older people generally experience high levels of resilience following disasters, older people with physical health conditions and limited mobility experience heightened vulnerability in the aftermath of disaster (Lowe et al., 2020).

The Great Recession (December 2007 to June 2009), the most severe recession in the United States since the Great Depression of the 1930s, had a long duration and slow recovery (Goodman & Mance, 2011). The recession affected older people who were already retired and living on fixed

incomes, as well as those still working, who risked losing jobs they would not be able to replace. More than 1.5 million Americans over the age of 50 lost their homes between 2007 and 2011 as a result of the mortgage crisis (Cagney et al., 2014). The Great Recession affected suicide rates (Stuckler et al., 2009), major depression, minor depression, dysthymia, generalized anxiety disorder, and panic attacks (Gili et al., 2013). Using data from the MIDUS study, Forbes and Krueger (2019) found that each recession-related stressor that a person experienced (e.g., financial loss, job-related change) was associated with long-lasting declines in mental health and Lee et al. (2010) found that elevations in depression between 2007 and 2009 were more marked in people aged 55–65 than in younger people.

In New Jersey, the Great Recession had particularly enduring economic effects. A 2019 study by the Pew Foundation found that state aid for local governments dropped nearly 8% from pre-recession funding making New Jersey one of many states that had not rebuilt its core fiscal reserves (Reitmeyer, 2019). During this time state tax revenue recovery in New Jersey fell well behind that of other states. High rates of poverty and millennials leaving New Jersey after high school, as well as low rates of job growth have left New Jersey's middle class with challenges that did not exist before the Great Recession (McKoy, 2014). Analyzing data collected in 2006 and in 2011, Pruchno et al. (2017) found that the Great Recession increased depressive symptoms experienced by older people in New Jersey regardless of age, gender, race, education, income, marital status, and work status.

Current Study

The analyses that follow build on findings from three previous analyses of data from the Ongoing Research on Aging in New Jersey: Bettering Opportunities for Wellness in Life (ORANJ BOWL) panel. The first analysis identified a significant increase in depressive symptoms between 2006 and 2011, the time during which the Great Recession unfolded (Pruchno et al., 2017). The second analysis, using data from the first three waves of ORANJ BOWL identified three trajectories of depressive symptoms (Mandavia & Bonanno, 2019). The third analysis revealed that peri-traumatic exposure to Hurricane Sandy in 2012 had effects on depressive symptoms that lasted up to 5 years after the hurricane (Wilson-Genderson et al., 2018).

In the current analyses, we question whether there is a distinct group of people who were more likely than others to have their depressive symptoms affected by exposure to Hurricane Sandy, accounting for the spike in depressive symptoms that occurred as a function of the Great Recession. We pose the following questions:

1. Can discrete groups of people experiencing different trajectories of depressive symptoms over a 12-year period be identified?

2. Do these groups have different demographic characteristics at baseline?
3. Is exposure to Hurricane Sandy differentially associated with an increase in depressive symptoms in these groups?
4. Can group membership be predicted from demographic characteristics and exposure to Hurricane Sandy?

Several aspects of our study design are unique, providing the opportunity to add novel information to what is known about how depressive symptoms unfold over time. First, our data are from a large, state-based sample of older people recruited from the community. Second, our data were collected before and after both the Great Recession and Hurricane Sandy, enabling us to examine the effects of disaster within its historical context.

Method

Participants

Between 2006 and 2008, we recruited and completed interviews with 5,688 people (Wave 1) who were part of the ORANJ BOWL panel. ORANJ BOWL was developed to study successful aging. We recruited participants using cold calling and list-assisted random-digit-dialing (RDD) procedures. Eligible participants were between the ages of 50 and 74, living in New Jersey, and able to participate in a 1-hr, English-language telephone interview. Coverage loss due to cell phone-only households was small due to sample demographics (Blumberg & Luke, 2007). ORANJ BOWL achieved a response rate of 58.73%, using standard American Association for Public Opinion Research calculations, and a Cooperation Rate of 72.88%, consistent with or better-than-average RDD response rates. See Pruchno et al. (2010) for details regarding sample development. Participants were representative of older adults (aged 50–74) living in New Jersey in 2006, except for a slightly higher rate of women and people with more years of education. Because we were unable to translate the interview into Spanish, ORANJ BOWL underrepresents Hispanics. At Wave 1, participants lived in 1,644 of New Jersey's 1,912 census tracts. Table 1 includes sample descriptive statistics.

One year after their baseline interview, a subsample of participants was re-contacted and asked to complete a personality measure (Wave 2). We excluded data from this wave in these analyses because we did not collect information about depressive symptoms at that wave.

In 2011, we mailed a questionnaire (Wave 3) to all ORANJ BOWL respondents (see Figure 1 for sample flow). Compared to those who died, withdrew, or did not complete the Wave 3 questionnaire, people completing the questionnaire ($N = 3,387$) had more years of education ($F = 47.85$, $df = 3$; $5,671$) and were wealthier ($F = 54.16$, $df = 3$; $5,018$). Completers were older than noncompleters but younger than those who withdrew or died ($F = 47.26$, $df = 3$; $5,684$). Completers were more likely to be women

than those who died ($X^2 = 21.36$, $df = 3$, $N = 5,688$) and less likely to be African American than those who died or did not complete Wave 3 ($X^2 = 97.48$, $df = 3$, $N = 5,688$). Of the participants eligible to complete Wave 3 (not lost prior to follow-up or to death or illness), 3,387 (62.7%) participated.

In 2014, approximately 18 months after Hurricane Sandy struck, we mailed a questionnaire (Wave 4) to all ORANJ BOWL respondents known to be alive at Wave 3. We called participants who did not complete the interview and whenever possible, completed the interview by telephone. Compared to those who died, withdrew, or did not complete the Wave 4 questionnaire, people completing the Wave 4 questionnaire ($N = 3,608$) had more years of education ($F = 64.36$, $df = 3$; $5,671$) and higher income ($F = 99.74$, $df = 3$; $5,018$). Completers were older than noncompleters but younger than those who withdrew or died since Wave 1 ($F = 90.14$, $df = 3$; $5,684$). Completers were more likely to be female than those who died ($X^2 = 15.02$, $df = 3$, $N = 5,688$) and less likely to be African American than noncompleters and those who died ($X^2 = 102.44$, $df = 3$, $N = 5,688$). The availability of additional funds for sample follow-up at Wave 4 resulted in a larger sample at Wave 4 ($N = 3,608$) than Wave 3 ($N = 3,387$) with a completion rate of 74% of eligible panel members.

Wave 5 was completed approximately 18 months after Wave 4 (2015–2017). Completers ($N = 3,076$) reported higher levels of education ($F = 116.76$, $df = 3$; $5,671$) and income ($F = 150.79$, $df = 3$; $5,018$) than those who died, withdrew, or did not complete Wave 5. Completers were significantly older than noncompleters and younger than people who withdrew or died ($F = 121.68$, $df = 3$; $5,684$). Completers were more likely to be female than those who died ($X^2 = 15.85$, $df = 3$, $N = 5,688$) and less likely to be African American than those who died, withdrew, or did not complete Wave 5 ($X^2 = 143.38$, $df = 3$, $N = 5,688$). Of eligible participants, 71% ($N = 3,076$) participated.

Wave 6 was completed approximately 18 months after Wave 5 (2017–2019). As in previous waves, completers ($N = 3,137$) reported higher levels of education ($F = 111.19$, $df = 3$; $5,671$) and income ($F = 155.77$, $df = 3$; $5,018$) than those who died, withdrew, or did not complete Wave 6. Completers were significantly older than noncompleters and younger than those that withdrew or died ($F = 157.97$, $df = 3$; $5,684$). Completers were more likely to be female than those who died ($X^2 = 12.89$, $df = 3$, $N = 5,688$) and less likely to be African American than those who died, withdrew, or did not complete Wave 6 ($X^2 = 108.85$, $df = 3$, $N = 5,688$). Of those eligible to participate, 82% ($N = 3,137$) participated.

Measures

Disaster exposure

Disaster exposure was assessed with four constructs: peritraumatic stress, personal and property loss, post-storm hardship,

Table 1. Sample Demographic Characteristics at Each Wave

	Wave 1 2006–2008 N = 5,688	Wave 3 2011 N = 3,387	Wave 4 2013–2015 N = 3,608	Wave 5 2015–2017 N = 3,076	Wave 6 2017–2019 N = 3,137
Age [M (SD)]	60.79 (7.10)	65.37 (7.01)	67.66 (6.92)	69.14 (6.73)	70.39 (6.66)
Sex (female)	3,621 (63.7)	2,202 (65.0)	2,326 (64.5)	1,956 (63.6)	1,996 (63.6)
African American	646 (11.4)	276 (8.1)	314 (8.7)	222 (7.2)	250 (8.0)
Income [number (%)]					
Less than \$15K	365 (6.4)	152 (4.5)	156 (4.3)	85 (2.8)	102 (3.3)
\$15K to \$30K	601 (10.6)	289 (8.5)	297 (8.2)	221 (7.2)	215 (6.9)
\$30K to \$50K	862 (15.2)	502 (14.8)	509 (14.1)	419 (13.6)	431 (13.7)
\$50K to \$80K	1,133 (19.9)	698 (20.6)	736 (20.4)	639 (20.8)	646 (20.6)
\$80K to \$150K	1,291 (22.7)	875 (25.8)	954 (26.4)	864 (28.1)	881 (28.1)
More than \$150K	770 (13.5)	520 (15.4)	573 (15.9)	516 (16.8)	534 (17.0)
Missing	666 (11.7)	351 (10.4)	383 (10.6)	332 (10.8)	328 (10.5)
Education [number (%)]					
Not HS graduate	306 (5.4)	115 (3.4)	113 (3.1)	59 (1.9)	61 (1.9)
HS graduate or general educational development	1,607 (28.3)	863 (25.5)	900 (24.9)	686 (22.3)	706 (22.5)
Some college	852 (15.0)	487 (14.4)	515 (14.3)	452 (14.7)	459 (14.6)
2-year college degree	530 (9.3)	320 (9.4)	356 (9.9)	313 (10.2)	312 (9.9)
4-year college degree.	1,108 (19.5)	697 (20.6)	769 (21.3)	681 (22.1)	714 (22.8)
Some post baccalaureate	220 (3.9)	162 (4.8)	164 (4.5)	148 (4.8)	153 (4.9)
Masters	743 (13.1)	521 (15.4)	563 (15.6)	516 (16.8)	517 (16.5)
Some post-Masters	73 (1.3)	50 (1.5)	52 (1.4)	47 (1.5)	45 (1.4)
Doctorate	236 (4.1)	168 (5.0)	171 (4.7)	171 (5.6)	167 (5.3)
Missing	13 (0.2)	4 (0.1)	5 (0.1)	3 (0.1)	3 (0.1)
Functional limitations [M (SD)]	40.08 (6.55)	40.78 (5.75)	40.95 (5.64)	41.22 (5.42)	41.26 (5.45)
Chronic illnesses [M (SD)]	1.76 (1.40)	1.70 (1.35)	1.66 (1.32)	1.60 (1.29)	1.57 (1.28)
Storm exposure					
Peri-traumatic stressors	—	—	0.86 (1.01)	—	—
Personal and property loss	—	—	0.54 (0.74)	—	—
Post-storm hardship	—	—	0.13 (0.37)	—	—
CES-D [M (SD)]	5.1 (5.1)	7.02 (5.4)	6.1 (5.4)	5.4 (4.9)	5.4 (4.9)

Notes: CES-D = Center for Epidemiological Studies-Depression scale; HS = high school; SD = standard deviation.

and geographic exposure. We measured peri-traumatic stress at Wave 4 using questions similar to those asked by Bell et al. (2017). Respondents reported on the extent to which they felt: (a) in immediate physical danger during Hurricane Sandy and (b) distressed or fearful during Hurricane Sandy using a 3-point scale: 0 (*no*), 1 (*a little*), or 2 (*a lot*). We summed responses to create a peri-traumatic stress score. The sample mean was 0.86 ($SD = 1.0$; range: 0–4; $\alpha = 0.69$).

Personal and property loss were assessed at Wave 4 by asking participants if because of Hurricane Sandy they had: experienced a physical injury, any home damage, a family or close friend injured or killed, lost utilities, damage to their automobile, or needed medical attention. Responses recorded on a dichotomous scale, 0 (*no*), 1 (*yes*), were summed to create a personal and property loss score ($M = 0.56$, $SD = 1.0$). As only six people experienced four or more of these stressors, this variable was capped at three (range: 0–3).

Post-storm hardship was assessed at Wave 5 by asking if the participant had: stopped working, moved out of their

home, experienced mold problems at home, or lost income because of Hurricane Sandy. Responses recorded on a dichotomous scale, 0 (*no*), 1 (*yes*), were summed to create a post-storm hardship score ($M = 0.13$, $SD = 0.37$). As just four people experienced three of these stressors, this variable was capped at two (range: 0–2).

Geographic exposure was defined as living in one of the nine counties in New Jersey that was hardest hit by Hurricane Sandy, as determined by FEMA (2018). These counties were: Atlantic, Bergen, Cape May, Essex, Hudson, Middlesex, Monmouth, Ocean, and Union. Living in a storm-affected area was denoted 0 (*no*) or 1 (*yes*); 3,216 (56.5%) of participants were living in a county affected by the storm.

Depressive symptoms

We measured depressive symptoms at each wave using the 10-item short form of the Center for Epidemiological Studies-Depression scale (CES-D; Andresen et al., 1994). Each item was

Figure 1. Ongoing Research on Aging in New Jersey: Bettering Opportunities for Wellness in Life (ORANJ BOWL) sample completions flow chart.

scored from 0 (*none of the time*) to 3 (*most of the time*). Two items (“*I felt hopeful about the future*” and “*I was happy*”) were reverse-coded. Higher scores indicated more depressive symptoms (range: 0–30; Cronbach’s $\alpha = 0.82$).

Lifetime diagnosis of depression

At baseline, participants indicated whether a physician had ever told them they had depression, anxiety, or another emotional problem. Responses were coded as 0 (*no*) or 1 (*yes*). A quarter of the sample reported having a lifetime diagnosis of depression ($N = 1,357$).

Demographic covariates

At baseline, respondents reported their age, gender (0 = *male*, 1 = *female*), income (range from 1 = *less than \$15,000* to 6 = *more than \$150,000*), educational attainment (range from 1 = *less than high school* to 9 = *doctoral degree*), and race (0 = *not African American*, 1 = *African American*).

Statistical Analysis

We examined means and standard deviations of CES-D scores for each wave. We created empirical growth plots for CES-D scores over time to examine the raw trajectories.

Preliminary examination of these plots suggested heterogeneity. To determine whether it was possible to simplify this heterogeneous set of depressive symptom trajectories into more homogeneous clusters, we developed latent class growth models (LCGMs; Nagin, 2005).

We built LCGM with classes varying from one to five, refining models to select the solution with the optimal number of classes, based on the lowest Bayesian information criteria (BIC) and robustness of the group size. We estimated the LCGM adjusting for death and lifetime diagnosis of depression to account for unequal probabilities of attrition (e.g., right censoring) among different depressive trajectories.

Next, we created trajectory plots presenting each LCGM class to permit examination of the average pattern of change within the identified classes. Classes are presented with 95% confidence intervals; if the confidence intervals do not overlap there is increased confidence that the groups are meaningfully distinct.

We tested the linear and quadratic models for the slope of the depressive symptom trajectories to assess if there was significant change over time and the pattern of that change for each of the LCGM groups. The linear change parameter captures a constant increase or decrease over time (straight line); a quadratic parameter captures change that is not strictly linear but rather may change in one direction (e.g., increase) and then another (e.g., decrease) over time. Next, we compared the groups on baseline participant characteristics and exposure to Hurricane Sandy. Finally, we used multinomial logistic regression to examine how baseline characteristics, death status, and exposure to Hurricane Sandy predicted group membership. Models were implemented using SAS 9.4 (SAS Institute Inc., 2015) proc traj.

Results

Can Discrete Groups of People Experiencing Different Trajectories of Depressive Symptoms Over a 12-Year Period Be Identified?

As shown in Table 1, and reported previously (Pruchno et al., 2017), the significant increase in CES-D scores between baseline and Wave 3 was most likely a function of the Great Recession. We compared the BIC for LCGM solutions with classes varying from one to four including covariates for participants lost due to death and lifetime diagnosis of depression: 44928.33 (1); 42539.23 (2); 41985.79 (3); 41824.76 (4) and selected the four-class solution as it had the lowest BIC. A five-group solution rendered two groups with fewer than 5% of the participants each and so was not considered.

Group 1 included 32.6% of the participants and had the lowest CES-D scores (intercept of 0.52) on average. People in Group 1 experienced a significant linear increase in depressive symptoms ($1.31, p < .001$), as well as a significant quadratic effect ($-0.18, p < .001$) indicating that the linear increase slowed in later

Table 2. Trajectory Group CES-D Means (SD) OverTime

	T1	T3	T4	T5	T6	
G1	1.42 (1.9)	2.71 (2.3)	1.85 (2.1)	1.64 (1.9)	1.74 (1.9)	T3 > T1, $p < .0001$ T3 > T4, $p < .01$
G2	4.52 (3.2)	6.79 (3.4)	5.78 (3.5)	5.4 (3.2)	5.5 (3.5)	T3 > T1, $p < .0001$ T3 > T4, $p < .005$
G3	10.16 (4.9)	12.55 (4.3)	11.15 (4.6)	10.31 (4.1)	10.11 (4.4)	T3 > T1, $p < .0001$ T3 > T4, $p < .001$
G4	16.19 (6.0)	18.48 (5.1)	18.01 (5.8)	17.22 (4.8)	16.94 (5.3)	T3 > T1, $p < .0001$

Notes: CES-D = Center for Epidemiological Studies-Depression scale; SD = standard deviation.

waves. Group 1 serves as the reference group for the risk adjustments for diagnosed depression and died. Group 2 included 43.6% of participants and had an intercept of 3.05. Group 2 also experienced a significant linear increase (1.55, $p < .001$), as well as a significant quadratic effect (-0.21 , $p < .001$) indicating that the linear increase slowed in later waves. Diagnosed depression was significantly associated with membership in Group 2 (1.02, $p < .001$) but death was not (0.74, $p = .099$). Group 3 included 19.0% of participants with an intercept of 8.31, a significant linear increase (1.87, $p < .001$), as well as a significant quadratic effect (-0.28 , $p < .001$) indicating that the linear increase slowed in later waves. Diagnosed depression was significantly associated with membership in Group 3 (2.45, $p < .001$) but death was not (0.67, $p = .150$). Group 4 included 4.8% of participants with an intercept of 14.28, a significant linear increase (1.93, $p < .001$), as well as a significant quadratic effect (-0.26 , $p < .001$) indicating that the linear increase slowed in later waves. Diagnosed depression (3.56, $p < .001$) and death (1.54, $p < .016$) were both significantly associated with membership in Group 4. Table 2 details the depressive symptom means for the four groups over time. See Supplementary Figure 1 to see a graph of the trajectory groups.

Do These Groups Have Different Demographic Characteristics at Baseline?

Comparisons of the four trajectory groups on demographic characteristics using MANOVA (Table 3) revealed that Group 4 (the group with the highest levels of depressive symptoms over time) had significantly more females and marginally more African Americans than the other groups. Group 4 also included more people who had been diagnosed with depression at baseline and who had died during the study. People in Group 4 were younger and had the lowest levels of education and income. In contrast, Group 1 (the group with a pattern of low depressive symptoms over time) included few people who at baseline had been diagnosed with depression. Group 1 included people with the highest levels of education and income.

Is Exposure to Hurricane Sandy Associated With an Increase in Depressive Symptoms?

Comparisons of the four trajectory groups on different types of storm exposure using MANOVA (Table 3) revealed a greater proportion of individuals in Group 4 living in Sandy affected areas (nearly 10% more) but this difference did not reach conventional levels of significance. Although the most depressed participants (Group 4) reported significantly greater levels of peri-traumatic stress exposure to Sandy, none of the four groups experienced an increase in depressive symptoms following Hurricane Sandy. No significant differences were found between the groups for personal and property loss or post-storm hardship.

Can Group Membership Be Predicted From Demographic Characteristics and Exposure to Hurricane Sandy?

Results of the multinomial logistic regression predicting group membership are reported in Table 4. Groups were differentiated by age, income, baseline depression diagnosis, and peri-traumatic stress in response to Hurricane Sandy. More specifically, Group 1 had higher income, was less likely to have a diagnosis of depression, and less likely to report peri-traumatic stress due to Sandy than the other groups. People in Group 4 were younger than those in Group 1.

Discussion

These analyses identified four groups of people who experienced distinct trajectories of depressive symptoms over 12 years. While the groups differed on level of depressive symptoms at baseline, each group experienced a linear increase in depressive symptoms that slowed in later waves. The most likely explanation for this pattern of increasing depressive symptoms between 2006 (Wave 1) and 2011 (Wave 3) and the subsequent decline is the Great Recession. In contrast, depressive symptoms did not increase significantly for any of the four groups following Hurricane Sandy. These results expand our understanding of how to interpret longitudinal trajectories of older adults' depressive symptoms in the context of time and place (Elder, 2014) and carry important implications for disaster response efforts.

Table 3. MANOVA Comparing the Groups on Demographic Indicators and Exposure

	G1 N = 1,146	G2 N = 1,601	G3 N = 657	G4 N = 162	<i>p</i>
	N (%)	N (%)	N (%)	N (%)	
Gender (female)	682 (0.60)	1,020 (0.64)	469 (0.71)	127 (0.78)	.0001
African American	90 (0.08)	133 (0.08)	65 (0.10)	21 (0.13)	.10
Depression Dx	72 (0.06)	268 (0.17)	315 (0.48)	119 (0.73)	.0001
Died	15 (0.01)	56 (0.03)	18 (0.03)	8 (0.05)	.01
Geographic exposure	642 (0.56)	913 (0.57)	368 (0.56)	107 (0.66)	NS
	<i>M (SD)</i>	<i>M (SD)</i>	<i>M (SD)</i>	<i>M (SD)</i>	
Age	60.37 (6.6)	60.94 (7.1)	60.31 (7.0)	59.4 (6.8)	.05
Education	4.76 (2.1)	4.32 (2.1)	3.83 (2.0)	3.45 (0.15)	.0001
Household income	4.55 (1.2)	4.18 (1.4)	3.71 (1.4)	3.19 (1.5)	.001
Peri-traumatic stress	0.7 (0.91)	0.84 (0.99)	1.1 (1.1)	1.3 (1.2)	.0001
Personal and property loss	0.55 (0.73)	0.52 (0.73)	0.55 (0.75)	0.59 (0.86)	NS
Post-storm hardship	0.12 (0.33)	0.13 (0.37)	0.14 (0.42)	0.15 (0.45)	NS

Notes: MANOVA = multivariate analysis of variance; NS = not significant; SD = standard deviation.

Table 4. Multinomial Logistic Regression Predicting Group Membership

	OR [95% CI]		
	G2	G3	G4
Age	—	—	0.95 [0.92, 0.98]
Gender (female)	—	—	—
Income	0.81 [0.75, 0.87]	0.61 [0.56, 0.67]	0.47 [0.41, 0.55]
African American	—	—	—
Depression Dx	3.12 [2.33, 4.19]	14.12 [10.31, 19.33]	46.92 [29.02, 75.86]
Died	—	—	—
Peri-traumatic stress	1.20 [1.09, 1.32]	1.52 [1.35, 1.72]	1.61 [1.34, 1.95]
Personal and property loss	—	—	—
Post-storm hardship	—	—	—
Geographic exposure	—	—	—

Notes: Reference group is Group 1. Only significant findings are provided. CI = confidence interval; OR = odds ratio.

Consistent with earlier findings from Pruchno et al. (2017), these analyses show an increase in depressive symptoms between 2006 and 2011, regardless of baseline depressive symptoms. The Great Recession was a history-graded event that affected the mental health and well-being of the whole population. These results parallel work by Glen Elder and colleagues (Elder, 2014) who documented how lives are linked in time and place and can collectively experience developmental outcomes.

Beyond the history-graded influence of the Great Recession, however, we also find that demographic characteristics (gender, age, education, and income) and a history of diagnosed depression affect the way that trajectories of depressive symptoms develop over time. People experiencing consistently high levels of depressive symptoms over time were women, had been diagnosed with depression at baseline, were less educated, and had lower incomes. These findings are consistent with what is known about

risk factors for depression, but highlight the powerful, long-term effects these demographic characteristics have on mental health.

Unlike the powerful effects that the Great Recession had on depressive symptoms, these analyses reveal that Hurricane Sandy was not associated with subsequent increases in depressive symptoms for any of the groups. In fact, for each of the groups, mean levels of depressive symptoms decreased slightly after the hurricane (between Waves 3 and 4). These effects are most probably attributable to a gradual recovery following the Great Recession and attenuation back to pre-recession levels of depressive symptoms, rather than to the hurricane.

Our findings reveal, however, that people who consistently experience high levels of depressive symptoms over time reported the highest levels of peri-traumatic stress during Hurricane Sandy. These findings add important information to our understanding about the

directional relationship between disaster exposure and depressive symptoms and offer implications for intervention. Although there is no evidence in our data that peri-traumatic stress led to an increase in depressive symptoms, people with higher levels of depressive symptoms before the storm felt more frightened by the disaster and reported higher levels of peri-traumatic exposure. These findings suggest that people with higher levels of depressive symptoms are a vulnerable group who are likely to be challenged when exposed to a disaster, such as a hurricane. Because people with high levels of depressive symptoms can be identified before a disaster strikes, resources can be directed to them both before and after disaster. These findings, however, underscore the importance of screening for depressive symptoms on a regular basis. Additionally, the powerful effects that being diagnosed with depression earlier in life and having low levels of income identify people likely to be vulnerable in the face of a disaster. ORANJ BOWL's longitudinal, prospective data provide an important perspective from which to understand the effects of Hurricane Sandy on depressive symptoms. These results expand the disaster literature that typically relies on cross-sectional and post-only longitudinal designs (Nandi et al., 2009; Pietrzak et al., 2013; Tang et al., 2014), demonstrating how a prospective longitudinal design provides unique information about how disasters affect depressive symptoms.

Our analysis has a number of strengths, including access to a large, state-based sample with prospective longitudinal data and use of a sophisticated analytic approach. Our ability to build on an established research panel provided a unique opportunity to model the effects of time, disaster, and the economic recession. However, like all studies, this one had limitations. First, all data (exclusive of geographic exposure) relied on self-reports. The lower reliability of our peri-trauma stress measure suggests that future research should include additional items to create robust measures of disaster exposure. Second, because we did not a priori set out to study the effects of the Great Recession, the timing of our baseline and follow-up assessments was not optimal; these time points only serve as a reasonable approximation of the Recession's impact, especially given its long-lasting effects. Additionally, because we did not collect data regarding specific exposure to the Great Recession paralleling those regarding Hurricane Sandy, we cannot make causal attributions about how the economic recession affected depressive symptoms. Third, study attrition resulted in underrepresentation of people with lower education, lower income, and minority status. Not unlike other longitudinal panel studies of aging individuals (Allman et al., 2011; Cacioppo & Cacioppo, 2018; Ofstedal & Weir, 2011; Radler & Ryff, 2010), people who withdrew from the study or died were older and frailer than people remaining in the study. It is also likely

that people who did not participate in the post-Sandy interviews suffered more disaster damage and more depressive symptoms than people who continued to participate. We did control for right censoring of data due to death of participants, but it is not possible to know what the depressive symptom trajectories for those participants might have revealed. Moreover, it is likely that collecting data 18 months after Hurricane Sandy yielded an incomplete picture of the proximate effects that the hurricane had on depressive symptoms. Although it is difficult to launch large-scale data collection following a disaster, future studies that are able to overcome this limitation and collect data more proximate to the disaster will provide critical information. Similarly, more frequent data points may better capture the experiences of older people. As such, generalizability is limited and it is likely that our analyses underestimate the strength of association of exposure with depressive symptoms. Finally, generalization is limited as findings are based on data from a single cohort (Elder, 2014).

Despite these limitations, findings from these analyses add important information to our understanding about how large-scale events, such as an economic recession, and a natural disaster, such as Hurricane Sandy, affect the depressive symptoms of older people. Findings further demonstrate the importance of understanding an individual's previous lifetime trajectory of depressive symptoms when interpreting the impact of more recent life events on current depressive symptoms, underscoring the salience that a life course approach brings to understanding the effects of disaster on mental health (Lowe et al., 2020). Finally, these analyses highlight the importance of building and supporting research panels such as ORANJ BOWL as they can provide unique opportunities to understand how historical events and natural disasters affect people.

Supplementary Material

Supplementary data are available at *The Journals of Gerontology, Series B: Psychological Sciences and Social Sciences* online.

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Conflict of Interest

None declared.

Author Contributions

R. Pruchno planned the study, supervised the project, and wrote the paper. M. Wilson-Genderson planned the study, performed all statistical analyses, and wrote the paper. A. Heid planned the study and wrote the paper. F. Cartwright supervised data collection activities and wrote the paper.

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