Longitudinal Assessment of Cognitive and Psychosocial Functioning After Hurricanes Katrina and Rita: Exploring Disaster Impact on Middle-Aged, Older, and Oldest-Old Adults

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Abstract

The authors examined the effects of Hurricanes Katrina and Rita (HKR) on cognitive and psychosocial functioning in a lifespan sample of adults 6 to 14 months after the storms.

Participants were recruited from the Louisiana Healthy Aging Study (LHAS). Most were assessed during the immediate impact period and retested for this study. Analyses of pre-and post-disaster cognitive data confirmed that storm-related decrements in working memory for middle-aged and older adults observed in the immediate impact period had returned to pre-hurricane levels in the post-disaster recovery period. Middle-aged adults reported more storm-related stressors and greater levels of stress than the two older groups at both waves of testing. These results are consistent with a burden perspective on post-disaster psychological reactions.

Keywords

Natural disasters; environmental stressors; hurricane effects; oldest-old; Louisiana Health Aging Study

The hurricane season of 2005 devastated the entire Gulf Coast, including the Alabama and Mississippi coasts, South Louisiana, and portions of southeast Texas. To be precise, Hurricane Katrina made landfall on August 29, 2005 with over 1800 deaths (Graumann, et al., 2006). Four weeks later, Hurricane Rita made landfall on September 24, 2005, affecting mostly southwest Louisiana and southeast Texas. Rita, also a Category 3 storm, directly caused seven deaths (National Hurricane Center, 2007). Prior research has addressed psychological reactions to natural disasters including threats to mental health for disaster-affected individuals (e.g., post-traumatic stress disorder, anxiety, depression; see Norris et al., 2002; Norris & Elrod, 2006). There is a small but growing literature on natural disaster effects on children, older adults and families (Cherry, 2009; Kilmer, Gil-Rivas, Tedeschi, & Calhoun, 2009). Understanding the impact of natural disasters from a lifespan developmental perspective is essential for effective disaster planning and the development of age-sensitive, post-disaster interventions for recovery (Dass-Brailsford, 2009; Osofsky, Osofsky, & Harris, 2007). In this article, we focus on the impact of Hurricanes Katrina and Rita on select measures of cognitive and psychosocial functioning assessed longitudinally in a lifespan sample of adults who ranged in age from mid 20's to over 90 years old to provide new evidence bearing on this issue.

The Louisiana Healthy Aging Study (LHAS), a multidisciplinary study on the determinants of longevity and healthy aging, was in the third year of data collection when Hurricanes Katrina and Rita (HKR) struck the Gulf Coast. Accordingly, pre-disaster indices of cognitive and psychosocial functioning were available which permits the use of a prospective research design. In our prior work, Cherry et al. (2010) assessed middle-aged (47 to 64 years), older (65 to 89 years) and the oldest-old adults (90 years and older) during the immediate impact period, defined as October, 2005 to January, 2006. Analyses of pre- and post-disaster cognitive data showed storm-related decrements in working memory for the middle-aged and older adults, but not for the oldest-old. Regression analyses confirmed that social engagement and storm-related disruption significantly predicted pre- to post-disaster differences in short-term and working memory for the middle-aged and older adults only. These findings are consistent with a burden perspective on post-disaster psychological reactions (Solomon, Smith, Robins, & Fischbach, 1987). That is, the burden hypothesis holds that middle-aged persons will be more affected than other age groups because of their role as the economic provider with social and financial responsibilities for their families (Norris & Elrod, 2006; Thompson, Norris & Hanacek, 1993). For some, dual sets of responsibilities associated with caring for dependent children and elderly parents may double the perceived burden (Solomon et al., 1987).

Our prior work has also focused on self-reported coping strategies before and after the 2005 storms (Cherry, Silva, & Galea, 2009). Qualitative analyses of participants' responses to

open-ended questions administered in the immediate impact period (Wave 1) revealed that most people engaged in instrumental coping activities, although the two older groups spontaneously mentioned spiritual forms of coping more often than did the middle-aged group. These findings imply increased reliance on religious coping in a disaster context in later life. Interpretative caution is warranted, because Cherry et al. did not include a direct measure religious coping in Wave 1 testing. We assessed participants' self-reported religiosity and their religious beliefs and practices in Wave 2 to provide new evidence concerning religious coping in a post-disaster context. We also included an open-ended question to provide additional insight into their use of religious coping strategies with the storms and their aftermath. Emergent themes from the open-ended religious coping question are reported elsewhere (Marks, Cherry, & Silva, 2009; Silva, Marks, & Cherry, 2009; Tausch et al., 2011).

The primary objective of this investigation was to provide a longitudinal assessment of post-disaster well-being in the LHAS sample using cognitive and psychosocial indicators obtained before the storms and in the immediate impact period. Relatively few studies have examined post-disaster responses longitudinally with older adult samples (see Phifer, Kaniasty, & Norris, 1988; Phifer & Norris, 1989). Our main concern was to demonstrate the reliability of our first findings (Cherry et al., 2010; Cherry, Galea, & Silva, 2008) and extend them to include religious coping in a post-disaster context. Most of the individuals who participated in Wave 1 testing were retested in this study. We added a younger reference group (26 to 44 years) for whom pre-disaster measures were available to increase the breadth of inferences pertaining to lifespan differences in post-disaster psychological reactions. Our secondary objective in this study was to provide new evidence concerning the use of religious beliefs and practices as a method of dealing with post-hurricane stressors. Paragment (1997), among others, has made the point that religious coping can have a positive effect on health and managing the stressors of everyday life (see also Koening, 1995; Idler & Kasl, 1997a; Krause, 1998). Other evidence has shown that religious behaviors such as church attendance are associated with better physical functioning for older persons (e.g., Idler & Kasl, 1997b). In the weeks and months after the 2005 storms, faith-based communities made a tremendous contribution to the relief effort (see Cain & Barthelemy, 2008; Cherry, Allen, & Galea, 2009, for discussion). Faith and religious beliefs were also discussed by some LHAS participants as a form of coping in Wave 1 (Cherry, Silva, & Galea, 2009). In an initial investigation, we found that religious beliefs and religious coping were negatively correlated with health-related quality of life in the LHAS sample (Silva Brown et al., 2010). These findings imply that individuals who are less physically capable may be more likely to rely on religiosity as a coping method. However, Silva Brown et al. did not examine religiosity in relation to storm impact, storm-related stressors, perceived social support or participation in charitable activities including volunteer work and the disaster relief effort, thus further research is necessary.

To summarize, we expected minimal pre- to post-disaster differences in the cognitive and psychosocial measures for the oldest-old adults at Wave 2 testing, replicating our immediate impact period findings and extending them to the post-disaster recovery period. Of greater interest is the pattern of outcomes for the middle-aged and older adults. Specifically, they showed greater storm-related cognitive deficits than the oldest-old adults at Wave 1 testing, consistent with a burden perspective. Further decline in cognitive performance relative to baseline or the persistence of poorer performance comparable to Wave 1 would indicate the longevity of hurricane-related effects. Alternatively, a return to pre-hurricane levels of cognitive performance for these age groups would imply recovery.

Method

Participants

All participants were enrolled in the LHAS. These individuals were sampled randomly from the Voters Registration 2000 files for those age 20 to 64 years old and from the Medicare Beneficiary Enrollment Data file of the Center for Medicare and Medicaid Services (CMS) for those age 65 years older and above for the eight parishes (counties) constituting the Greater Baton Rouge community. LHAS participants tested within the eight-month period prior to the storms (January 18 to August 23, 2005) were recruited within the first 4 to 5 months after Rita and Katrina for Wave 1 testing (Cherry et al., 2010). Of the 66 people in the first study, 59 of them participated in this study 6 to 14 months after the storms for an 89% completion rate. To control for the length of time between Wave 1 and Wave 2 assessments, these participants were retested within a uniform interval (8 ± 3 months) following participation in the first study. The average number of days elapsed between assessments was 197.8 days (6.6 months) for the middle-aged adults, 188.3 days (6.3 months) for the older adults, and 193.1 days (6.4 months) for the oldest-old adults. We added a new group of 13 LHAS participants between the ages of 26 to 44 for whom we had pre-hurricane baseline data collected in the same 8-month period before the storms as the other age groups. Our rationale for including these younger adults was to provide a wider age range in Wave 2 testing than had been the case in the immediate impact study. The four age groups at Wave 2 testing consisted of younger adults (n = 13; 2 males, 11 females; age range 26 to 44 years), middle-aged adults (n = 17; 10 males, 7 females; age range 47 to 64 years), older adults (n = 19; 8 males, 11 females; age range 65 to 89 years), and oldest-old adults (n = 23; 10 males, 13 females; age 90 years and older).

A short form of the Wechsler Adult Intelligence Scale vocabulary subtest (Jastak & Jastak, 1964) was given as a measure of verbal intelligence prior to the storms. At pre-HKR baseline, an ANOVA on the vocabulary scores yielded a significant age group main effect, $F(3, 74) = 2.97$, $p = .0.04$. Pairwise comparisons, adjusted with respect to Tukey's inequality, showed that mean scores for the younger, middle-aged, and older adults did not differ from each other (see Table 1). All scored at least a 25 or higher on the Mini-Mental State Exam (MMSE) Folstein, Folstein & McHugh, 1975) and were free of neurologic impairment due to stroke or adult dementia prior to the storms. All were compensated $20.00 each for their voluntary participation.

Materials and Procedure

Selected pre-disaster measures of cognitive status and psychosocial well-being were re-administered in this study. The MMSE (Folstein et al., 1975) was given to assess potential changes in cognitive status. The Forward and Backward digit span measures from the WAIS-R (FDS, BDS)(Wechsler, 1981) and the Size Judgment span task (SJS) (Cherry, Elliott, & Reese, 2007) were given to assess changes in short-term memory and working memory capacity. Participants completed a religiosity questionnaire with four modules, which was developed for this study and modeled after Krause (1998). The *organizational religiosity and faith community involvement* module assessed religious affiliation and religious participation in group settings. Two questions assessed the frequency of attendance at religious services and participation in religious activities other than services (e.g., bible study groups, prayer groups) using a 5-point rating scale, where 1 = *never,* 2 = *a few times a year*, 3 = *a few times a month, 4 = at least once a week, 5 = nearly everyday.* Responses were summed to yield a composite index of faith community involvement. The *non-organizational religiosity* module assessed solitary religious participation (e.g., reading religious literature, watching religious programs). Two questions assessed the frequency of reading the Bible or other religious literature and listening or watching religious programs

on the radio or television (1 = *never* to 5 = *nearly everyday*). Participants also rated how religious they are (1 = *not at all,* 2 = *not very,* 3 = *somewhat,* 4 = *moderately,* 5 = *very*). Responses were summed to yield a composite non-organizational religiosity index. The *religious beliefs and practices* module assessed seeking comfort using sacred thoughts and behaviors. Two questions assessed the frequency of seeking comfort in your religious beliefs (i.e., sacred thoughts such as *God will not give me more than I can handle* and *All things work together for the good of those that love God*) and religious practices (e.g., praying, reading scripture, fasting, attending religious services). These questions were rated on a 5-point scale, where 1 = *never,* 2 = *rarely,* 3 = *sometimes,* 4 = *often,* 5 = *almost all of the time.* Responses were summed to yield a composite religious beliefs and practices index. The *religious coping* module assessed receiving personal strength and support from God and seeking God's guidance. Three questions assessed participants' views on receiving personal strength and support from God when dealing with difficult times, the use of prayer for coping with difficulties and stresses, and the importance of seeking God's guidance when making important life decisions. These questions were rated on a 4-point scale (1 = *strongly disagree,* 2 = *somewhat disagree,* 3 = *somewhat agree,* 4 = *strongly agree*). Responses were summed to yield a composite religious coping index.

The structured storm impact questionnaire from Wave 1 was re-administered, which was modeled after a similar instrument used to assess the psychological sequelae of the 2004 Florida hurricanes (cf. Acierno et al., 2007). Four modules cover *storm exposure and threat to self and family/property* (assessed evacuation status and fear for safety of self, friends and/or family); *storm-related disruption and stressors* (questions about environmental/ property issues and disruptions due to the storms); *social support* (availability of help if needed, charitable giving, volunteer work done for others, etc.); and *lifetime exposure to potentially traumatic events* (having experienced other extraordinarily stressful or disturbing events). In this article, we focus on the first three modules, because Cherry et al. (2010) found that very few participants reported prior trauma experiences such as serious accident, attacked by weapon, attacked without weapon but intent to kill/injure, and military combat or war zone. However, more than half of the sample had experienced other natural disasters, such as hurricane, major earthquake, flood, and tornado and for some the experience resulted in fear for life/safety. Analyses of participants' responses to items in the fourth module here replicated our earlier findings with no significant group or time of testing effects, so no further discussion of lifetime exposure to traumatic events is warranted.

Informed consent was obtained for all participants at the beginning of the session. The procedures used in this study were reviewed and approved by the institutional review board of Louisiana State University in Baton Rouge, LA. Participants were tested individually in their home or in the lab at LSU in two sessions that lasted approximately 60 to 90 minutes each. Younger participants were tested in a single session, if desired. The same invariant order of administration of the dependent measures was used across the one and two session formats. Details on the LHAS hurricane study materials and procedures are described more fully elsewhere (cf. Cherry et al., 2008; Cherry, Silva, & Galea, 2009).

Statistical analysis

These data were analyzed according to the following plan. A mixed model approach was used for testing for change from pre-HKR to Wave 1 and Wave 2 (time of testing main effect) and age group main effect with Age Group x Time of Testing interaction included in each model. These analyses were confined to the middle-aged, older, and oldest-old age groups who participated in Wave 1 and Wave 2 testing. For continuous variables, means and standard deviations are reported unless stated otherwise. The results of F-test and corresponding p-values are reported where appropriate. The frequencies and proportions (%) are reported unless stated otherwise for categorical variables. The results of χ^2 test and

corresponding *p*-values are reported where appropriate. For comparison purposes, analyses that included the younger adult group were confined to pre-HKR and Wave 2 assessments, applying an ANOVA approach for continuous responses and frequency analysis for categorical responses to test for differences among four age groups. All statistical analysis was carried out using SAS Version 9.1.3 statistical software system.

Results

Analyses of Individual Difference Characteristics

Table 1 presents a summary of the individual difference and social activity characteristics of the sample. Analyses of the MMSE scores yielded a significant age group effect, $F(3, 77.2) = 12.31$, $p < .0001$. At pre-HKR, means for the younger, middle-aged and older adults exceeded the mean of the oldest-old adults, which trend remained in effect at post-HKR Wave 1 and Wave 2 testing. A χ^2 test of independence revealed no significant association between educational attainment and age group ($p = 0.28$). Participants were active in the community. Most reported membership in 1 to 3 clubs and social organizations, although the number of clubs and social organizations was not significantly associated with age group at pre-HKR ($\chi^2 (6) = 9.74$, $p = 0.14$), Wave 1 ($\chi^2 (4) = 2.20$, $p = 0.70$), and Wave 2 ($\chi^2 (6) = 5.43$, $p = 0.49$). Before the storms, the association between the number of hours per week spent outside of the home and age group was non-significant, ($\chi^2 (3) = 5.82$, $p = 0.12$). After the storms, the association between these variables was significant, owing to the middle-aged adults who reported spending more than 19 hours outside the house more often than expected in Wave 1 (80.0%), ($\chi^2 (2) = 14.62$, $p = 0.0007$) and Wave 2 (88.2%), ($\chi^2 (3) = 13.97$, $p = 0.003$) compared to pre-HKR (55%). Participants rated their satisfaction with social support they receive for dealing with day to day problems. Before the storms, social support ratings and age group were significantly associated, $\chi^2 (6) = 26.97$, $p = 0.001$. As can be seen in Table 1, two older groups selected very satisfied with social support more often than expected, a trend that remained significant at Wave 1, $\chi^2(4) = 11.41$, $p = 0.02$ and Wave 2, $\chi^2(6) = 30.12$, $p < 0.001$. Participants indicated whether they had a confidant, described as someone they can talk to about issues that concern them. Analyses of the confidant ratings yielded a non-significant association to age group before the storms ($\chi^2(3) = 0.96$, $p = 0.81$), and at Wave 1 ($\chi^2(2) = 3.27$, $p = 0.20$) and Wave 2 ($\chi^2(3) = 4.38$, $p = 0.22$).

Cognitive Measures

Table 2 presents short-term and working memory performance before and after the storms for the middle-aged, older, and oldest-old adults[1]. Analyses of the FDS and BDS data yielded non-significant age group and time of testing effects ($p > 0.5$ for all). Analyses of the SJS data yielded significant main effects of age group, $F(3, 74.5) = 17.1$, $p < 0.0001$, time of testing, $F(2, 56.8) = 14.49$, $p < 0.0001$, and a significant Age Group x Time of Testing interaction effect, $F(4, 67.1) = 2.48$, p 0.052. As can be seen in Table 2, the middle-aged and older adult groups showed a drop in SJS performance at Wave 1 relative to pre-HKR. Importantly, we observed a significant improvement for the middle-age and older groups at Wave 2 compared to Wave 1 ($p < 0.03$ for both). Means for the oldest-old group did not significantly differ across the three times of testing. Additional pairwise comparisons were carried out to examine age group differences in SJS performance within the three testing intervals. Middle-aged and older adults' span estimates exceeded those of the oldest-old at pre-HKR and Wave 2, but not at Wave 1. Taken together, these results imply that the

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[1]Younger adults were not included in the analyses of short-term and working memory performance because the digit span measures were administered to them only in Wave 2 testing. As expected, the younger adults' performance on these measures was numerically higher than their older counterparts for FDS ($M = 6.42$, $SD = 1.30$), BDS ($M = 4.85$, $SD = 1.26$), and SJS ($M = 5.00$, $SD = 0.68$).

declines observed in working memory span for middle-aged and older adults in the immediate impact period were temporary in that both age groups returned to pre-HKR levels of performance at Wave 2 testing.

Religiosity Questionnaire

The majority reported that their religious affiliation was either Baptist (30.6%) or Catholic (26.4%), followed by Methodist (12.5%), Full Gospel/Pentecostal (9.7%), Presbyterian/ Lutheran (5.6%), non-denominational (5.6%), Episcopalian (4.2%), Mormon (2.8%), or atheist/no affiliation (2.8%)(see Table 3). Most (84.7%) indicated that they were an official member of a church or other place of worship. To summarize, most of these participants were at least nominally religious and many were highly so, consistent with research on the high religiosity of the South as a region (Silk & Walsh, 2006). As can be seen in Table 3, none of the responses differed by age group (all $F's < 2.50$ and all $p's > 0.07$), so we collapsed over this variable in the correlation analyses reported later on.

Storm Impact Measures

We compared responses to the storm impact questionnaire at Wave 1 and Wave 2 testing to provide new evidence pertaining to the reliability of participants' recollection of storms and their impact in the post-disaster recovery period (see Tables 4, 5, and 6). Analyses of responses across two waves of testing are confined to the middle-aged, older, and oldest-old age groups for whom data were collected in both waves. Analyses with the younger adult group focus on Wave 2 responses only.

Storm Exposure, Threat and Storm-Related Disruption—Few participants evacuated from their home as the result of either storm, yet nearly half of the sample experienced some winds/potential flooding and one third reported property damage (see Table 4). Analyses of participants' reported fear during the storms yielded a significant group main effect, owing to the middle-aged adults (1.72) who were somewhat more afraid than the older (1.36) and oldest-old (1.22) groups $F(2, 63) = 3.37$, $p = 0.04$. The time of testing main effect was also significant, $F(1, 56) = 3.98$, $p = 0.05$. The least squares means of responses indicated that participants reported more fear at Wave 1 (1.50) than at Wave 2 (1.36). Analyses of reported actual safety yielded a significant main age group effect, $F(2, 63) = 5.54$, $p = 0.006$, due to the middle-aged adults (1.79) who felt less safe than the older (1.29) and oldest-old adults (1.45) did. Very few participants were displaced from their home. Most reported lost of electricity service and many lost telephone service. Damage or loss of properties, such as household contents, sentimental possessions, and automobiles were reported in 10% or less participants, although approximately one-third of the sample reported loss of trees and crops.

Storm-Related Stressors—Participants were asked to indicate whether they experienced eleven storm-related stressors and if yes, how stressful was the experience (see Table 5). For Wave 1, analyses yielded a significant association to age group for five of the eleven of the storm-related stressors (p 0.001 for all), owing to the middle-aged adults whose ratings were higher than expected on these items. These results were replicated at Wave 2, with the same five stressors showing a significant association to age group favoring the middle-aged adults (p 0.004 for all). In addition, a sixth stressor was significantly associated to age group in Wave 2, namely, trouble communicating by telephone or e-mail, due to the younger adults' responses, which were higher than expected (see Table 5).

Social Support—Table 6 presents participants' perceived social support and charitable work done for others. In all age groups, perceived social support did not differ before and after the storms tested at Wave 1 or at Wave 2. For charitable work done for others, at Wave

1, middle-aged adults reported greater amounts of volunteer work for others and charitable giving after the storms compared to before the storms (F(1,61.8) = 13.69, p = 0.003), however, this perceived difference disappeared when tested at Wave 2 (F(1,69.5) = 0.036, p = 0.95). The youngest group, when tested at Wave 2, demonstrated greater amount of involvement in charitable giving and volunteer work after the storms compared to before (F(1, 66.9) = 9.18, p = 0.0035). Oldest-old adults did not differ in charitable work for others before and after the storms tested at either wave. Finally, the middle-aged adults reported having worked in the shelters or provided disaster relief assistance to evacuees or medical/military personnel involved with the relief effort more frequently than the oldest-old tested at Wave 1 and at Wave 2 ($p < 0.01$ for both waves). However, the perception of involvement in the middle-age group changed significantly from Wave 1 to Wave 2, reporting less frequent work in shelters or provide less frequently disaster relief at Wave 2 compared to Wave 1 (F(1,59.9) = 9.74, p = 0.04). In spite of this decline, the middle-age-group at Wave 2 showed higher average involvement in work in shelters then only the oldest-old group (F(1,71.6) = 13.79, p = 0.008) and not higher than the old group (F(1,70.7) = 1.94, p = 0.80).

Interrelationships Among Religiosity and Storm Impact Variables

We conducted correlation analyses to test for the hypothesized associations among participants' religious beliefs and practices and select measures of storm-related threat and social support in the post-disaster recovery period. We collapsed over the age group variable in these analyses because the mean responses did not differ among the age groups. Contrary to expectation, the results yielded non-significant correlations among the 4 religiosity sum scores and participants' reported fear and actual safety during the storms, and social support available to them before and after the storms (p 0.11 for all). Significant associations occurred between selected religiosity sum scores and charitable work done for others, however. Our data support the hypothesis that organizational religiosity is significantly correlated with charitable work in a typical year before the storms, since the storms, and work in the shelters or other disaster relief (see Table 7). Non-organizational religiosity and religious beliefs and practices are both significantly correlated with charitable work since the storms. Taken together, these results are compatible with the monumental disaster relief response of faith-based communities in the wake of Hurricanes Katrina and Rita (Cain & Barthelemy, 2008; Cherry, Allen, & Galea, 2009).

Discussion

In this study, storm-related changes in cognitive and psychosocial functioning among younger, middle-aged, old, and oldest-old adults in the wake of Hurricanes Katrina and Rita were assessed using a prospective design. Prospective designs are desirable as salient participant characteristics have been measured prior to the disaster which permits meaningful inferences on disaster effects. The inclusion of two waves of testing is strength of this study in that it permits longitudinal inferences based on available indicators of psychosocial well-being from pre-hurricane baseline to immediate impact (Wave 1) and post-disaster recovery (Wave 2) periods. The present results provide new evidence concerning cognitive and psychosocial functioning after a major environmental stressor, as discussed next.

The primary objective of the present investigation was to replicate and extend our findings from the immediate impact period (Cherry et al., 2010) with a lifespan sample of adults. Analyses of psychosocial indicators of well-being yielded relatively little difference from pre-HKR to Wave 1 and Wave 2 testing for the middle-aged and two older groups. The more interesting finding concerns the variations in cognitive performance among the age groups. In particular, the storm-related declines in working memory for middle-aged and older adults in Wave 1 were reversed in Wave 2 (Table 2). The finding that these two groups

returned to their pre-hurricane levels of performance 6 to 14 months after the storms is exciting and suggestive of recovery. Interestingly, the oldest-old did not differ in short-term and working memory performance across the pre-HKR, Wave 1 and Wave 2 assessments, implying that these indicators of cognitive function may be temporally stable in very old adults within a two-year period of time.

Analyses of storm-related threat and actual safety during the storms indicated that middle-aged adults were somewhat more afraid and also felt less safe than did their older counterparts in Waves 1 and 2, confirming that the effect is reliable (Table 4). Younger adults' reported fear during the storms and perceived safety at Wave 2 was similar to that of the middle-aged adults. Furthermore, the middle-aged adults reported experiencing storm-related stressors more often than the other age groups for nearly half of the stressors included in this study (Table 5). Middle-aged adults were also more likely than their two older counterparts to report moderate to extreme stress associated with their experience of these storm-related stressors in Waves 1 and 2, consistent with a burden perspective on post-disaster psychological reactions (Solomon et al., 1987; Thompson et al., 1993). Note, however, that younger adults at Wave 2 who experienced these stressors reported numerically higher levels of stress associated with cancelling plans, providing assistance to evacuees, trouble getting gas, trouble communicating by telephone or email and changes in workplace than did the middle-aged adults. The finding that these storm-related stressors were more disturbing than expected for younger and middle-aged adults is compatible with prior research where older adults' showed minimal stress responses after a natural disaster (Ferraro, 2003; Ferraro, Morton, Knutson, Zink, & Jacobson, 1999; Knight, Gatz, Heller, & Bengtson, 2000; but see Phifer, 1990).

Participants' ratings of social support available to them before and after the storms were relatively high and did not change across assessments, confirming the reliability of the finding and suggesting that perceived social support is stable over time in this sample (Table 6). Acierno et al. (2007) reported that high perceived social support in the pre-disaster period serves a protective function against psychological disorders. Others have made the point that social support reduces post-disaster psychological distress and promotes well-being (Kaniasty, Norris, & Murrell, 1990; Norris & Kaniasty, 1996). Perhaps perceived social support may have buffered participants' experience of the two hurricanes that struck South Louisiana within four weeks of each other in 2005. Interpretative caution is warranted, as participants in this study were not directly affected by the storms, nor was there evidence of adverse mental health outcomes in the sample (Cherry et al., 2008). Those who experienced significant property damage and lengthy displacement due to the storms may have responded differently. In fact, David et al. (1996) found that half of their sample of 61 community-dwelling adults who were directly affected by Hurricane Andrew in 1992 met the clinical criteria for a new onset disorder 6 to 12 months after the storm. These disorder types included post-traumatic stress, major depression, and anxiety disorders which were assessed via self-report using a structured clinical interview. They also found that severe property damage, defined as destruction of major structures in the home, was significantly associated with mental health outcomes in their study. David et al.'s findings underscore the importance of conducting assessments long after the incident event has occurred, given the persistence of threats to well-being for directly hurricane affected individuals.

With respect to volunteer work and charitable giving, middle-aged adults reported significantly more activities of this nature after the storms than before the storms at Wave 1, although not at Wave 2. Younger adults reported more volunteer work and greater charitable giving after the storms compared to before at Wave 2. Oldest-old adults did not differ across the two assessments. Middle-aged adults were also more likely than their older counterparts

to report working in the shelters and providing disaster relief assistance at Wave 1, although this difference between middle-aged and older adults disappeared at Wave 2. Interestingly, oldest-old adults reported that they were not directly involved in disaster relief assistance, yet many of them sheltered storm-displaced family members with extended stays in their homes in some cases. Perhaps providing housing for displaced family and friends was reminiscent of intergenerational households and did not seem like disaster relief to the oldest-old. This notion is consistent with the maturation hypothesis where older adults show reduced emotional reactivity to stressful life events due to more mature coping styles or lower levels of pre-disaster stress generally (Knight et al., 2000). Further research is needed before firm conclusions are warranted, however.

A secondary objective in this study was to examine associations among self-reported religiosity and storm impact. On the assumption that religious beliefs and practices are resources that people draw upon in a post-disaster context (Tausch et al., 2011), we had expected that such spiritual resources would be related to participants' responses on the structured storm questionnaire and possibly more so for very old people relative to their younger counterparts. Contrary to expectation, the four religiosity scores were not associated with fear during the storm, perceived actual safety, and availability of social support before and after the storms, nor did the age groups differ on these scores. It is possible that very old adults may use religion differently than do their younger counterparts to cope with stressors, but further research is necessary. LHAS participants also live in the greater Baton Rouge area where personal losses were modest and community destruction minimal. Persons who lost their homes and experienced forced relocation and a lengthy displacement from their community due to the hurricanes may have responded differently. In contrast, we found that participation in organized religious activities was associated with charitable work done for others before and after the storms, as well as working in shelters or providing disaster relief (Table 7). Non-organized religiosity and religious beliefs and practices were also significantly correlated with charitable work done for others since the storms. These findings are exciting in that they provide initial confirmation of the content validity of the present measure of religiosity. Self-reported religiosity may also be a better indictor of the propensity to engage in helping behaviors in a disaster context than a resource for coping with their own storm-related stresses and experiences.

In closing, this study underscores the value of longitudinal assessment in a post-disaster context in that storm-related declines in cognitive function for middle-aged and older adults in the immediate impact period returned to pre-hurricane baseline in the post-disaster recovery period. Future research to explore the generality of these findings, particularly with a directly affected sample, is warranted.

Acknowledgments

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Table 1

Participant Characteristics and Social Engagement Before and After the Storms

	Younger adults	Middle-aged adults	Older adults	Oldest-old adults
		Mean (SD)		
Age (at wave 2)	37.7 (5.3)	54.6 (5.7)	74.8 (7.1)	92.4 (1.1)
Vocabulary	26.4 (4.9)	24.9 (7.9)	26.2 (7.0)	21.0 (6.6)
MMSE				
Pre-HKR	29.6 (0.7)	28.6 (2.4)	28.8 (1.3)	26.5 (1.8)
Wave 1 post-HKR	--	28.6 (1.7)	28.9 (1.6)	27.0 (1.5)
Wave 2 post –HKR	29.4 (1.1)	28.3 (2.9)	28.2 (2.8)	26.3 (2.2)
		N (%)		
Education Level				
High school graduate or less	3 (23.1%)	6 (30.0%)	3 (15.0%)	12 (46.2%)
College	7 (53.8%)	11 (55.0%)	15 (75.0%)	12 (46.2%)
Graduate school	3 (23.1%)	3 (15.0%)	2 (10.0%)	2 (7.6%)
Clubs and Social Organizations				
None				
Pre-HKR	1 (7.7%)	2 (10.0%)	1 (5.0%)	3 (11.5%)
Wave 1 post-HKR	--	0 (0.0%)	1 (5.0%)	2 (7.7%)
Wave 2 post-HKR	1 (7.7%)	0 (0.0%)	1 (5.3%)	1 (4.3%)
1 to 3				
Pre-HKR	12 (92.3%)	13 (65.0%)	16 (80.0%)	13 (50.0%)
Wave 1 post-HKR	--	14 (70.0%)	12 (60.0%)	14 (53.8%)
Wave 2 post-HKR	11 (84.6%)	12 (70.6%)	11 (57.9%)	13 (56.5%)
Over 4				
Pre-HKR	0 (0.0%)	5 (25.0%)	3 (15.0%)	10 (38.5%)
Wave 1 post-HKR	--	6 (30.0%)	7 (35.0%)	10 (38.5%)
Wave 2 post-HKR	1 (7.7%)	5 (29.4%)	7 (36.8%)	9 (39.1%)
Hours per week outside home				
19 hours or less				
Pre-HKR	7 (53.8%)	9 (45.0%)	7 (35.0%)	18 (69.2%)

	Younger adults	Middle-aged adults	Older adults	Oldest-old adults
Wave 1 post-HKR	--	3 (15.8%)	11 (55.0%)	19 (73.1%)
Wave 2 post-HKR	6 (46.2%)	2 (11.8%)	11 (57.9%)	16 (69.6%)
> 19 hours				
Pre-HKR	6 (46.2%)	11 (55.0%)	13 (65.0%)	8 (30.8%)
Wave 1 post-HKR	--	16 (80.0%)	9 (45.0%)	7 (26.9%)
Wave 2 post-HKR	7 (53.8%)	15 (88.2%)	8 (42.1%)	7 (30.4%)
Social Support[1]				
Very satisfied				
Pre-HKR	6 (46.2%)	11 (55.0%)	17 (85.0%)	24 (92.2%)
Wave 1 post-HKR	--	10 (50.0%)	14 (70.0%)	24 (92.3%)
Wave 2 post-HKR	6 (46.2%)	8 (47.1%)	15 (78.9%)	21 (91.3%)
Fairly satisfied				
Pre-HKR	3 (23.1%)	8 (42.11%)	3 (15.0%)	1 (3.9%)
Wave 1 post-HKR	--	9 (45.0%)	5 (25.0%)	2 (7.7%)
Wave 2 post-HKR	3 (23.1%)	9 (52.9%)	4 (21.1%)	2 (8.7%)
A little/not satisfied				
Pre-HKR	4 (30.8%)	0 (0%)	0 (0%)	1 (3.9%)
Wave 1 post-HKR	--	1 (5.0%)	0 (0%)	0 (0%)
Wave 2 post-HKR	4 (30.8%)	0 (0%)	0 (0%)	0 (0%)
Confidant				
Yes				
Pre-HKR	12 (92.3%)	19 (95.0%)	19 (95.0%)	23 (88.5%)
Wave 1 post-HKR	--	18 (90.0%)	20 (100.0%)	22 (84.6%)
Wave 2 post-HKR	13 (100.0%)	17 (100.0%)	19 (100.0%)	21 (91.3%)

Notes. Entries for Wave 1 based on a total sample size of 66, with 20 middle-aged, 20 older, and 26 oldest-old adults. Entries for Wave 2 based on a total sample size of 72, with 13 younger, 17 middle-aged; 19 older, and 23 oldest-old adults.

[1] Only 3 younger adults at pre-HKR and 2 younger adults at Wave 2 testing reported "not satisfied at all" in the question regarding overall support from other people dealing with personal or day-to-day problems.

Table 2

Short-term and Working Memory Performance Before and After the Storms

	Pre-HKR	Wave 1 post-HKR	Wave 2 post-HKR	*P-value*
		Mean (SD)		
FDS[a]				
Middle-aged adults	6.22 (0.96)	6.00 (1.15)	6.16 (1.14)	0.75
Older adults	5.74 (1.08)	5.78 (1.23)	5.87 (1.19)	0.87
Oldest-old adults	5.56 (1.27)	5.48 (1.38)	5.41 (1.21)	0.50
BDS				
Middle-aged adults	4.67 (1.38)	4.53 (1.49)	4.65 (1.30)	0.18
Older adults	4.21 (1.33)	4.40 (0.91)	4.50 (1.28)	0.87
Oldest-old adults	3.94 (1.20)	4.08 (1.43)	3.93 (1.20)	0.70
SJS[b]				
Middle-aged adults	4.83 (0.75)	4.08 (0.99)	4.72 (0.93)	0.0002
Older adults	4.13 (0.62)	3.58 (0.71)	4.21 (0.56)	0.003
Oldest-old adults	3.35 (0.60)	3.31 (0.90)	3.52 (0.59)	0.19

Notes.

[a] Forward Digit Span (FDS) and Backward Digit Span (BDS) from the Wechsler Adult Intelligence Scale-Revised (WAIS-R; Wechsler, 1981).

[b] Size Judgment Span (SJS; Cherry, Elliott & Reese, 2007). The *p*-value relates to the time of the test effect within each age group.

Table 3

Summary of Religiosity and Faith-Based Behaviors

	Age group				
	Younger	**Middle-aged**	**Older**	**Oldest-old**	**Total**
Organizational Religiosity			N (%)		
Religious affiliation[a]					
Catholic	1 (7.7%)	5 (29.4%)	4 (21.1%)	9 (39.1%)	19 (26.4%)
Baptist	7 (53.9%)	2 (11.8%)	6 (31.6%)	7 (30.4%)	22 (30.6%)
Methodist	2 (15.4%)	2 (11.8%)	3 (15.8%)	2 (8.7%)	9 (12.5%)
Episcopalian	0 (0.0%)	1 (5.9%)	1 (5.3%)	1 (4.3%)	3 (4.2%)
Presbyterian or Lutheran	0 (0.0%)	0 (0.0%)	3 (15.8%)	1 (4.3%)	4 (5.6%)
Mormon	1 (7.7%)	0 (0.0%)	0 (0.0%)	1 (4.3%)	2 (2.8%)
Non-denominational	1 (7.7%)	2 (11.8%)	1 (5.3%)	0 (0.0%)	4 (5.6%)
Full gospel or Pentecostal	1 (7.7%)	3 (17.6%)	1 (5.3%)	2 (8.7%)	7 (9.7%)
Atheist or no affiliation	0 (0.0%)	2 (11.8%)	0 (0.0%)	0 (0.0%)	2 (2.8%)
Official member[b]					
No	1 (7.7%)	5 (29.4%)	4 (21.1%)	1 (4.3%)	11 (15.3%)
Yes	12 (92.3%)	12 (70.6%)	15 (78.9%)	22 (95.7%)	61 (84.7%)
	Means (SD)				**F**	**p**
Faith community involvement	7.00 (1.63)	5.88 (2.55)	5.74 (2.26)	5.43 (2.25)	1.42	0.25
Non-organizational religiosity	10.77 (2.28)	9.65 (3.69)	9.47 (2.99)	10.83 (2.74)	1.06	0.37
Religious beliefs and practices	9.23 (1.36)	7.18 (2.63)	7.16 (2.54)	7.61 (2.35)	2.50	0.07
Religious coping	11.69 (0.85)	9.65 (3.44)	9.89 (3.02)	10.70 (1.55)	2.08	0.11

Notes. Entries for faith community involvement and religious beliefs and practices reflect the sum of scores based on three questions. Entries for non-organizational religiosity and religious coping reflect the sum of scores based on two questions.

[a] Non-significant association with age group, $\chi^2(24) = 27.17$, $p = 0.296$.

[b] Non-significant association with age group, $\chi^2(3) = 5.81$, $p = 0.12$.

Table 4

Storm Exposure, Threat, and Storm-Related Disruption

	Age group				
	Younger	Middle-aged	Older	Oldest-old	Total
Storm Exposure, Threat, and Storm-Related Disruption			N (%)		
Evacuate					
Yes / Wave 1	--	3 (15.0%)	0 (0.0%)	5 (19.2%)	8 (12.1%)
Yes / Wave 2	2 (15.4%)	2 (11.8%)	0 (0.0%)	4 (17.4%)	8 (11.1%)
Present for winds/major flooding					
Yes / Wave 1	--	13 (65.0%)	12 (60.0%)	3 (11.5)	28 (42.4)
Yes / Wave 2	8 (61.5%)	10 (58.8%)	9 (47.4)	5 (21.7)	32 (44.4)
Property damage					
Yes / Wave 1	--	11 (55.0%)	5 (25%)	4 (15.4%)	20 (30.3%)
Yes / Wave 2	4 (30.8%)	9 (52.9%)	5 (26.3%)	4 (17.4%)	22 (30.6%)
			Means (SD)		
Fear of injury/death					
Wave 1	--	1.85 (0.75)	1.35 (0.81)	1.31 (0.62)	
Wave 2	1.92 (0.86)	1.59 (0.71)	1.37 (0.83)	1.13 (0.46)	
Actual safety					
Wave 1	--	1.70 (0.57)	1.25 (0.55)	1.38 (0.50)	
Wave 2	1.77 (0.60)	1.88 (0.60)	1.32 (0.48)	1.52 (0.59)	
Storm-related disruption			N (%)		
Displaced from home					
Yes / Wave 1	--	4 (20.0%)	0 (0.0%)	0 (0.0%)	4 (6.1%)
Yes / Wave 2	1 (7.7%)	0 (0.0%)	0 (0.0%)	1 (4.3%)	2 (2.8%)
Loss of services					
Electricity					
Yes / Wave 1	--	18 (90.0%)	18 (90.0%)	24 (92.3%)	60 (90.9%)
Yes / Wave 2	13 (100.0%)	14 (82.4%)	15 (79.9%)	19 (82.6%)	61 (84.7%)
Telephone					
Yes / Wave 1	--	6 (30.0%)	3 (15.0)	7 (26.9%)	16 (24.2%)

	Age group				
	Younger	**Middle-aged**	**Older**	**Oldest-old**	**Total**
Yes / Wave 2	8 (66.7%)	6 (37.5%)	1 (5.9%)	9 (39.1%)	24 (35.3%)
Damage or losses					
Household contents					
Yes / Wave 1	--	5 (26.3)	0 (0.0%)	2 (7.7%)	7 (10.8%)
Yes / Wave 2	0 (0.0%)	4 (23.5%)	2 (10.5%)	1 (4.4%)	7 (9.7%)
Sentimental possessions					
Yes / Wave 1	--	1 (5.3%)	0 (0.0%)	0 (0.0%)	1 (1.5%)
Yes / Wave 2	0 (0.0%)	2 (11.8%)	1 (5.3%)	0 (0.0%)	3 (4.2%)
Automobiles, trucks					
Yes / Wave 1	--	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Yes / Wave 2	0 (0.0%)	0 (0.0%)	1 (5.3%)	0 (0.0%)	0 (0.0%)
Pets					
Yes / Wave 1	--	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Yes / Wave 2	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Crops, trees					
Yes / Wave 1	--	8 (42.1%)	4 (20.0%)	7 (26.9%)	19 (29.2%)
Yes / Wave 2	8 (61.5%)	7 (41.2%)	2 (10.5%)	4 (17.4%)	21 (29.2%)

Notes. Entries for Wave 1 based on a total sample size of 66, with 20 middle-aged, 20 older, and 26 oldest-old adults. Entries for Wave 2 based on a total sample size of 72, with 13 younger; 17 middle-aged; 19 older, and 23 oldest-old adults.

Table 5

Storm Related Stressors

	Younger	Middle-aged	Older	Oldest-old	χ^2	P
		N (%)				
Cancel planned events/activities						
Wave 1	--	15 (75.0%)	8 (40.0%)	7 (26.9%)	10.88	0.004
Wave 2	10 (76.9%)	10 (58.8%)	9 (47.4%)	2 (8.7%)	19.03	0.0003
Relatives/friends refused to evacuate						
Wave 1	--	2 (10.0%)	1 (5.0%)	3 (11.5%)		ns
Wave 2	3 (23.1%)	2 (11.8%)	3 (15.8%)	3 (13.0%)		ns
Housed evacuees in home						
Wave 1	--	10 (50.0%)	10 (50.0%)	8 (30.8%)		ns
Wave 2	4 (30.8%)	9 (52.9%)	11 (57.9%)	8 (34.8%)		ns
Provide assistance to evacuees						
Wave 1	--	12 (60.0%)	7 (35.0%)	2 (8.0%)	13.83	0.001
Wave 2	8 (61.5%)	8 (47.1%)	6 (31.6%)	0 (0.0%)	18.19	0.0004
Lose food in refrigerator or freezer						
Wave 1	--	11 (55.0%)	6 (30.0%)	7 (26.9%)		ns
Wave 2	7 (53.9%)	9 (52.9%)	5 (26.3%)	5 (21.7%)		ns
Trouble getting gasoline						
Wave 1	--	11 (57.9%)	6 (30.0%)	1 (3.9%)	16.09	0.0003
Wave 2	11 (84.6%)	10 (58.8%)	2 (10.5%)	0 (0%)	37.04	< 0.0001
Trouble meeting medical/health needs						
Wave 1	--	2 (10.0%)	1 (5.0%)	1 (3.9%)		ns
Wave 2	2 (15.4%)	0 (0.0%)	1 (5.3%)	2 (8.7%)		ns
Cancel medical treatments						
Wave 1	--	2 (10.0%)	2 (10.0%)	3 (11.5%)		ns
Wave 2	1 (7.7%)	2 (11.8%)	2 (10.5%)	2 (9.1%)		ns
Trouble communicating by telephone or email						
Wave 1	--	14 (70.0%)	7 (35.0%)	11 (42.3%)		ns
Wave 2	12 (92.3%)	8 (47.1%)	8 (42.1%)	7 (30.4%)	13.32	< 0.004

	Younger	Middle-aged	Older	Oldest-old	χ^2	P
		N (%)				
Trouble getting around town						
Wave 1	--	19 (95.0%)	16 (80.0%)	12 (46.2%)	14.24	0.0008
Wave 2	12 (92.3%)	16 (94.1%)	13 (68.4%)	6 (26.1%)	26.10	0.0001
Changes in workplace						
Wave 1	--	13 (65.0%)	5 (25.0%)	0 (0%)	24.15	0.0001
Wave 2	8 (61.5%)	8 (47.1%)	4 (21.1%)	0 (0%)	19.81	0.00201

Notes. Entries for Wave 1 based on a total sample size of 66, with 20 middle-aged, 20 older, and 26 oldest-old adults. Entries for Wave 2 based on a total sample size of 72, with 13 younger; 17 middle-aged; 19 older, and 23 oldest-old adults. Entries reflect percentages of questioned.

[1] Entries are based on this scale: 0 = *no,* 1 = *yes*

Table 6

Social Support Before and After the Storms

Type of support[1]	Younger adults	Middle-aged adults	Older adults	Oldest-old adults
		Wave 1		
Someone to help you[2]				
6 months before storms	--	12.70 (3.16)	13.70 (2.49)	11.73 (3.31)
Since the storms	--	12.55 (3.09)	14.16 (1.57)	11.96 (3.19)
Charitable work you may do for others[3]				
A typical year before storms	--	5.05 (1.73)	4.95 (2.11)	4.35 (1.94)
Since the storms	--	5.65 (1.69)	5.20 (2.00)	4.31 (2.28)
Work in the shelters or provide disaster relief	--	1.15 (1.04)	0.50 (0.83)	0.04 (0.20)
		Wave 2		
Someone to help you[2]				
6 months before storms	12.85 (2.23)	12.88 (4.26)	13.47 (2.04)	11.52 (3.51)
Since the storms	12.85 (2.51)	12.38 (4.30)	13.47 (2.06)	11.52 (3.53)
Charitable work you may do for others[3]				
A typical year before storms	5.00 (1.47)	5.38 (2.16)	4.58 (2.24)	4.35 (2.14)
Since the storms	5.54 (1.61)	5.38 (1.93)	4.63 (2.24)	4.17 (2.44)
Work in the shelters or provide disaster relief	0.46 (0.66)	0.76 (0.56)	0.42 (0.84)	0.00 (0.00)

Notes: Entries reflect means and standard deviations. Wave 1 data are based on a total sample size of 66 (20 middle-aged, 20 older, and 26 oldest-old adults). Wave 2 data are based on a total sample size of 72 (13 younger; 17 middle-aged; 19 older, and 23 oldest-old adults).

[1] Entries are based on this scale: 0 = *none of the time*, 1 = *some of the time*, 2 = *most of the time*, 3 = *all of the time*

[2] Based on the sum of scores of 5-item questionnaire

[3] Based on the sum of scores of 3-item questionnaire

Table 7

Interrelationships among Storm-Related Charitable Work and Religious Beliefs and Practices at Wave 2

Type of religiosity	Charitable work done for others		
	A typical year before the storms	Since the storms	Work in the shelters
Organizational religiosity and faith-based community involvement	0.29 *	0.33 **	0.29 **
Non-organizational religiosity	0.22	0.25 *	0.08
Religious beliefs and practices	0.21	0.25 *	0.18
Religious coping	0.18	0.19	0.13

Notes. Entries are Pearson correlation coefficients.

*
p 0.05

**
p 0.01