Hurricanes and the Elderly: The Role of Social Networks in Age-Related Vulnerability*

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Abstract

Because of increased health concerns, fewer economic resources, and reduced social capital, elderly individuals are said to be at increased risk of the impacts of a disaster. Social capital resources can be especially important in counteracting vulnerability to disaster impacts by increasing the likelihood of hearing disaster warning information, assisting with preparation and evacuation, and recovering following an event by providing financial or nonfinancial assistance. Based on preliminary analyses of the first two years of a three year panel study of residents along the Atlantic and Gulf coasts of the United States, we analyze the relation between age and indicators of disaster vulnerability with specific attention to general and disaster-related social capital. Our results point to the understanding that the effect of age on disaster risk and recovery is less about age itself and instead dependent upon the social and economic circumstances that correspond with age.

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This study consists of a critical analysis of disaster vulnerability data regarding elderly individuals living in high hurricane risk areas of the United States. In 2010, 40.4 million Americans were over the age of 65, making up about 13% of the country's population. With this population increasing and the high concentration of elderly in some of the most hazard prone states (Peek, 2010), research on the elderly in disaster settings is a timely and important area of study.

Elderly persons have been identified at greater vulnerability to disaster impacts. Age-related physiological issues, including declining health and cognitive functioning, are one manner in which the elderly are at increased risk of injury, death, and physical and psychological loss during disasters. For example, advanced age was the single most important factor in determining who died during Hurricane Katrina, with 67% of those who perished over the age of 65 (Peek 2010). But aspects of elderly individuals' social environment, including their individual social capital from informal network ties and connections to community resources, can counteract or compound these physiological vulnerabilities. Unfortunately, we know less about the effects of these social processes on disaster risk and recovery for this demographic (Klinenberg 2002). Drawing on two years of panel survey data about hurricane preparedness with residents of the U.S. Gulf and Atlantic coasts, we expand on this issue and contribute to the discussion on age-related vulnerability to disaster.

Our data presented in this paper includes individual and household characteristics often used as proxies for social vulnerability (e.g., age, disability, gender, income, housing type), indicators of social capital (e.g., network connections and resources during evacuation and recovery, contact with community members, ties to formal support organizations), measures of

hurricane preparedness (e.g., having food, water, a NOAA radio), and perceived barriers to evacuation (e.g., cost, assistance to evacuate, transportation costs and access). We present preliminary analyses highlighting differences in disaster-specific social capital available for elderly and non-elderly persons and the effect of age and social capital on preparedness activities and perceived barriers to hurricane evacuation. We begin with a review of the literature on the specific vulnerability that elderly persons face in disaster and the role of social capital in this vulnerability. After a brief review of our methods, we discuss descriptive differences between elderly and non-elderly persons in disaster vulnerability and general and disaster-specific social capital, then analyze of the effect of these items on hurricane preparedness and reported barriers to evacuation. Our study provides an early attempt at measuring disaster-specific social capital for this population pre-disaster and conceptualizing how it may or may not impact age-related disaster vulnerability. We conclude with a discussion of the implications of our findings and directions for future research.

Elderly Vulnerability to Disaster

Social vulnerability to disaster is described as, "the characteristics of a person or group and their situation that influence their capacity to anticipate, cope with, resist and recover from the impact of a natural hazard" (Wisner et al. 2004: 11). The social vulnerability to disaster perspective is used to describe how social relations among groups within a given society create differential impacts of disaster for different parts of the population (Phillips and Fordham 2010). Research has shown that groups with less access to resources, including economic, political, and social resources, suffer disproportionately during a disaster. This vulnerability is commonly related to demographical characteristics. For example, women, minorities, persons with

disabilities, persons living in poverty, and the elderly often face increased or differential impacts from a disaster because of social stratification of resources in society (Phillips et al. 2010).

When disaster strikes, older individuals are among those that are most likely to perish (Bolin and Klenow 1983; Peek 2010). This difference in disaster impacts for elderly persons is less a direct function of age but related to changes commonly associated with aging, including changed economic resources, physical and mental health declines, and changes in social network support and connection (Perry and Lindell 1997).

Economic Resources, Elderly, and Disaster

Economic resources are central to understanding vulnerability to disaster—those with greater economic resources are able to mitigate, prepare, respond, and recover from disasters often more quickly and with less impact on their standard of living (for review, see Fothergill and Peek 2004). In particular, persons living in poverty are especially vulnerable to disaster impacts because of they are more likely to live in riskier areas and in substandard or rented housing, lack health and property insurance, are socially excluded or have more difficulty accessing economic and political resources such as formal and informal disaster aid, and are at greater risk of losing employment in low-wage sectors following disaster.

Elderly poverty and economic resources have been a particular area of interest in gerontology and disaster research. Elderly poverty has been declining since the 1960s because of government programs such as Social Security (Engelhardt and Gruber 2004). The median income of households headed by an individual aged 65 and older was around $45,000 in 2010, slightly less than the median $49,000 for non-elderly households (DeNavas-Walt, Proctor, and Smith 2011). In 2010, 9% of elderly persons lived below the poverty level and an additional 5.8% were defined as near poor (living below 125% the poverty level). When health care costs

are included along with governmental aid programs, the elderly poverty rate jumps to nearly 16%, and any future reductions in Social Security or governmental benefits will greatly impact the economic standing of the elderly population (AoA 2011; Engelhardt and Gruber 2004). During disasters, elderly individuals living in poverty and those on fixed incomes from personal or governmental retirement accounts have difficulty accessing resources, shelters, establishing relief plans, or even providing means for mobilization when evacuating (Durant 2011). For example, Bolin and Klenow (1983) found that elderly persons on fixed incomes had more difficulty getting post-disaster loans, thus nearly twice as many elderly respondents than non-elderly respondents reported a drop in their standard of living following disaster.

On the other hand, studies have shown that elderly persons with higher socioeconomic statuses are more likely to report adequate insurance coverage and greater access to federal aid (Ngo 2001). Because of their age, elderly populations may have more wealth established than younger persons, and this wealth helps to recover from disaster impacts. The Administration on Aging (2011) reported that 80% of households headed by an elderly person owned their homes, and a majority of these (65%) owned their homes free and clear. Being home owners with adequate insurance greatly increases the likelihood of recovery from disaster, but some evidence indicates that because of fixed incomes, even elderly households with economic resources and insurance have more difficulty making up a discrepancy between the financial losses and what is covered by insurance than their younger counterparts (Bolin and Klenow 1983).

Health, Elderly, and Disaster

Declining physical and mental health is the most common explanation of the elderly population's differential vulnerability to disaster. Because advancing age is correlated with the likelihood of having chronic health concerns or special needs that increase physical frailty,

elderly individuals may have limited ability to respond to disaster warnings and take protective action (Durant 2011; Peek 2010). Elderly persons are more likely than younger persons to report at least one chronic health condition, including hypertension, arthritis, heart disease, cancer, and diabetes and are three times as likely than non-elderly persons to spend time in the hospital over the course of a year (AoA 2011). A large minority (37%) of elderly persons in the U.S. also reported some type of disability in 2010.

These health concerns affect all phases of disaster from mitigation to recovery. Health and disability will affect elderly individuals receiving warnings, mean that they require specialized medicine, medical care, and physical assistance to evacuate and these requirements must be quickly accessible after a disaster, and limit their ability to do the physical labor required during disaster recovery (Peek 2010). The challenges faced by the elderly when considering the physical and psychological vulnerabilities lead to concept of the "frail elderly" who require increased attention. "Frailty" can best be understood as a lack of biological reserve and resilience that acutely affects the elderly population (McCann 2011). In relation to a disaster this can leave little possibility for frail elders to respond efficiently to natural disasters without assistance. Regarding disabilities specifically, individuals with a physical disability may have greater difficulty receiving and interpreting disaster warning information, taking protective actions (e.g. tucking under tables during an earthquake), preparing their supplies for evacuation and evacuating without assistance, and completing recovery clean-up following an event (Clive et al. 2010).

The increased potential of health concerns, combined with the fixed and/or low incomes suggests that elderly persons may require additional assistance to mitigate, respond, and recovery from a disaster. Thus these economic and health vulnerabilities facing elderly persons can be

either counteracted or compounded by their social situations, including their living arrangements and social capital.

Social Capital, Elderly, and Disaster

Social capital describes the resources available through network connections with other people and groups (Bourdieu 1985). Social capital is important during disaster as informal and formal connections, such as friends, neighbors, family, and community organizations, communicate warnings, help mitigate and prepare property for impact, provide shelter and supplies, and offer immediate aid, debris removal, and initial recovery assistance (Elliott, Haney, and Sams-Abiodun 2010; Hawkins and Maurer 2010; Hurlbert, Haines, and Beggs 2000). Throughout the history of the sociology of disaster literature, research has shown that neighbors are the real "first" responders who check on the well-being of others and provide immediate life-saving assistance. Family and friends also provide financial and nonfinancial assistance during disaster. Kaniasty and Norris (1995) showed that individuals with larger social networks receive more tangible (e.g. debris removal), informational (e.g. directions to formal aid resources), and emotional (e.g. encouragement) assistance following disaster. Unfortunately, social network size, in general, declines with age in the U.S., even as reduced physical and cognitive abilities leave elderly populations more dependent on others for assistance in normal circumstances and, thus, during disasters (Geller 2009).

Both living arrangements and connections to the general community are important to understanding elderly's social capital and vulnerability to disaster. While we often conceive of elderly persons living in nursing homes or with family members, the proportion of elderly persons living alone has climbed substantially in the past few decades. For example in 2009, only 4% of elderly individuals lived in institutional settings, and in contrast, nearly one-third of

the non-institutionalized elderly population lived alone (AoA 2011). Smaller household sizes mean fewer individuals to hear warnings and fewer others to help with protective actions, such as home preparations, and participate in property repairs (Peek 2010).

Beyond living arrangements, ageing results in declining number of connections to the broader community, especially through the common institutions of paid employment or educational involvement. Lack of involvement with others can increase disaster vulnerability by reducing the possibility of hearing a warning, knowing where and how to get needed assistance, and even cause elderly individuals to avoid community resources out of fear of victimization. The term "pattern of neglect" has been used in research to describe findings that indicate elderly individuals were less likely to receive formal assistance from government and community organizations whether that assistance be tangible or emotional, and they are less likely to draw upon primary group (family, neighbor, friends) networks for aid during or after a disaster (Bolin and Klenow 1983; Kilijanek and Drabek 1979). This pattern of neglect may be a result of the smaller social networks of elderly responds. As Kaniasty and Norris (1995) showed, individuals with larger support networks, in general, report greater amounts of support following disaster, and controlling for network size and amount of disaster impact, elderly receive equivalent amounts of support to non-elderly persons.

But, given that elderly persons may be at increased risk because of less economic resources and declining health, equivalent social network support may not close this gap in age-related vulnerability. And many frail and isolated elderly persons will continue to face detrimental impacts of disaster as clearly shown by Klinenberg (2002). The 1995 Chicago heat wave 73% of heat wave deaths were elderly individuals. These deaths were concentrated geographically in neighborhoods that were low-income, elderly, minority, and prone to violence.

A combination of isolation from family, lack of connection to community institutions, and fear of interacting with community members because of potential victimization led to these deaths. Without social capital that supports interaction with the community in times of crisis and request assistance *and* network connections who would check on their well-being during crisis, elderly individuals perished disproportionately. In a sad end to that disaster, 41 victims (or 8% of the total number of victims) were buried together in a mass grave because there was no one to claim their bodies.

These three areas of concern for elderly populations bring us to our research interests on the role of social capital and age in hurricane vulnerability. Our study provides the first prospective look at the perception of disaster assistance available through social networks, and details about the location and form of this assistance.

Data and Methods

The survey data was drawn from the first two years of a three-year panel study on coastal residents' hurricane risk perception, preparedness, and evacuation intention. We began a mail survey of coastal residents between Wilmington, North Carolina and Brownsville, Texas in June 2010, and the second survey wave was conducted in May 2011 with a 68% retention rate.

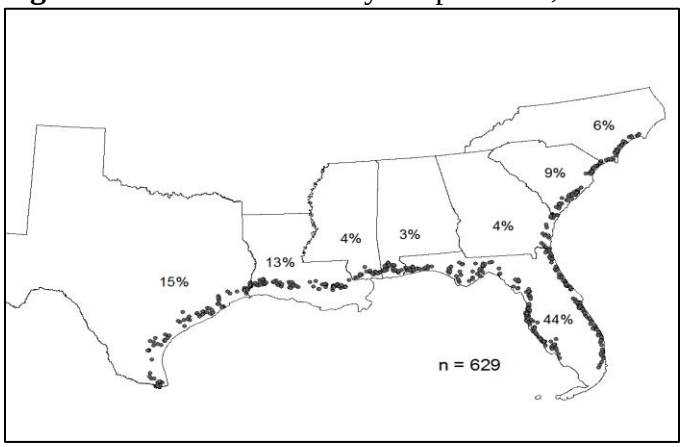
Sampling

A stratified sampling strategy was used to recruit a spatially uniform set of participants who lived within 10 miles of the Atlantic or Gulf coasts. Figure 1 shows the location of respondents.[1] To draw this sample, we identified the census tracts falling within a 10-mile buffer

[1] There are approximately 2,500 miles of coast within the sampling frame area after subtracting the northern part of North Carolina, the southern tip of Florida from Homestead to Naples, and portions of the Louisiana coast to account for the complicated structure of that coast. We also excluded the Florida Keys because of the unique conditions faced there in terms of exposure and evacuation. On average, we had one sample point every 4.3 miles, approximately 60 sample points within any given hurricane warning area (about 250 miles of coast), and approximately 25 sample points within any typical hurricane landfall impact area (about 100 miles of coast) in an attempt to have a subset of the population affected by a hurricane during the three years of the project.

of the coast in the area of study. Census tracts were arrayed and quota samples (e.g., every kth tract, k individuals per tract) were taken to establish a uniform spread of cases along the coast. A sample of 1,200 households was drawn to specification by Survey Sampling International.[2] The University of Wisconsin Survey Center performed the data collection following best practices described by Dillman (1978), including pre-contact, follow-up prompts, a second mailing, and cash incentives ($5). The response rate to the first wave was 53%, resulting in 629 cases. Panel attrition for the second wave was approximately 30%, resulting in 427 respondents who completed both surveys. The returned surveys were coded and entered into a spreadsheet by The University of Wisconsin Survey Center. We uploaded these results into Stata/IC 12.1 for analysis.

Figure 1. Location of Survey Respondents, Wave 1 2010



Questionnaire Development and Variables

The questionnaires were evaluated through iterative expert review and a pre-test in which 180 individuals, in a convenience sample of coastal residents in Florida and Louisiana, completed the questionnaire and provided open-ended comments on the question items. The

[2] Prior to implementing the survey, a power analysis was conducted to establish the sample size needed for the overall study, for analysis of subgroups, and to account for anticipated rates of panel attrition. It was determined that in a spatially random sample strategy, an initial panel size of 575 would be needed. Hedeker, Gibbons, and Waternaux (1999) provide formulae, software, and examples for calculating power in panel designs with attrition. We used their approach that takes the correlational structure of the repeated measure into account.

original questionnaire was also translated from English to Spanish and reviewed by three fluent Spanish speakers.[3]

The questionnaires included demographic, hurricane experience, and social capital items. We used standard response sets (i.e., U.S. Census) to collect demographic data such as date of birth, gender, race and ethnicity, household income, wealth, educational attainment, household size, and presence of individuals with disabilities in the household. From information on income, we created a poverty variable. We used 2010 poverty thresholds to identify poor households in our sample. Only a small number of cases were below this threshold, thus we developed a near-poor designation to identify cases living at or below 150% of the poverty threshold. The information we collected on hurricane experience included number of years living near the coast, type of housing and whether owning or renting, and past hurricane experience and evacuation.

We included items to assess two types of social capital: general social capital and disaster-specific social capital. General social capital included extended family in the community, frequency of talking with neighbors, and organizational membership. We developed disaster-specific social capital items to assess the availability of evacuation and recovery assistance. We asked respondents about the availability of family or friends to stay with during an evacuation, the distance of travel necessary to reach these individuals, and the length of time the respondent could stay, as well as the number of persons the respondent could rely on for financial or nonfinancial assistance during a hurricane and the geographic location of these individuals.

Our dependent variables in this study are two scales developed from sets of items measuring hurricane preparedness and evacuation: 1) Preparedness Scale and 2) Evacuation Barriers Scale (see Table 1 for items). The Preparedness Scale is a summed scale of 18 binary

[3] No Spanish language surveys were returned, thus the second wave was only developed in English.

items included in Wave 2 data collection. Higher scores indicate more preparedness activities undertaken. The Evacuation Barriers Scale is a summed scale of 21 five-point Likert-scaled items asking about general and transportation concerns that would affect respondents' ability to evacuate. This scale was originally developed in Wave 1, then revised and extended in Wave 2. Scores indicate relative position among respondents in terms of what hinders evacuation.

Table 1. Evacuation Barriers Scale and Preparedness Scale

Scale	Range, α	Individual Items
Preparedness Scale	0 – 18 α = 0.81	1. Identify a safe room in the house to shelter in. 2. Identify escape routes from your home. 3. Have a predetermined place for household members to meet. 4. Have a NOAA weather radio. 5. Have a first aid kit. 6. Have at least 1 gallon of water per day, per person for 3-7 days. 7. Have enough non-perishable packaged or canned food for 3-7 days. 8. Have an emergency kit with flashlight, tools, radio, toiletries, etc. 9. Have important documents in a watertight container. 10. Have an axe. 11. Evaluate home's vulnerability to storm surge. 12. Evaluate home's vulnerability to wind. 13. Know home's insurance for wind damage. 14. Know home's insurance coverage for flooding. 15. Have improved home's roof wind resistance (crack sealing). 16. Have roof tie-downs installed. 17. Have permanent storm shutters. 18. Have temporary storm shutters.
Evacuation Barriers Scale	21 – 105 α = 0.92	*My ability to evacuate would be affected by my ability . . .* 1. to get away from work responsibilities. 2. to leave work due to lost income. 3. to prepare my home for storm impacts. 4. to afford travel. 5. to leave my property unprotected. 6. to leave because of my pet(s). 7. to receive an evacuation order in time. 8. to know where to go in an evacuation. 9. to get supplies together to evacuate. 10. to get motivated to leave home. 11. to find a place to stay when evacuating. 12. to provide care giving responsibilities. 13. my ability to get a reliable vehicle to use. 14. the availability of gasoline. 15. the cost of gasoline. 16. impassable bridges. 17. flooded roads I would need to use. 18. traffic congestion out of my area. 19. traffic accidents. 20. getting transportation for the entire family. 21. transporting a family member or friend with special needs.

Results

In the following, we provide descriptive and inferential results related to elderly respondents' social capital and disaster vulnerability. We define elderly as respondents who were 65 years or older in 2010.[4] Table 2 provides demographics on our sample, with differences between elderly and non-elderly respondents included. Our sample, in general, is older, mostly white, and highly educated. As expected, elderly persons are more likely to be retired than other respondents and have lived on the coast for more years. They also have completed more education than younger respondents. Individuals from both age groups have experienced approximately five hurricanes.

Table 2. Sample Demographics, Elderly and Non-Elderly Respondents

	All (n = 629) Mean (SD)/ Percent	Elderly (n = 237) Mean (SD)/ Percent	Not Elderly (n = 392) Mean (SD)/ Percent
Households with an elderly person	43.6	-	9.4
Age in years	59.7 (14.6)	74.0 (6.1)	51.0 (10.1)
Percent white	88.2	91.6	86.2**
Percent female	44.7	41.8	46.4
Education**			
High school degree	56.6	57.0	56.4
College degree	19.6	14.8	22.5
Graduate/professional degree	23.9	28.3	21.2
Employment***			
Full-time	47.5	9.7	70.2
Part-time	4.5	2.5	5.6
Retired	37.0	78.9	11.8
Not employed	11.0	8.9	12.3
Years living on coast	31.9 (19.4)	36.6 (21.4)	21.1 (17.6)***
Hurricanes experienced	4.53 (4.72)	4.49 (4.73)	4.56 (4.71)

* $p \leq 0.10$, ** $p \leq 0.05$, *** $p \leq 0.01$ (two-tailed test)

Household Disaster Vulnerability

Disaster vulnerability relates to household characteristics, including characteristics of respondent's living situation (homeownership, type of structure, insurance), economic resources

[4] Between 2010 and 2011, 18 respondents aged into the elderly category. Unless otherwise specified, we maintain 2010 designations.

(income, living in poverty, and wealth), disability status of household members, and number of household members. Table 3 shows the household characteristics of our sample. A large majority of the elderly respondents (78%) indicated that all members of their household were over 65. Elderly respondents also report significantly fewer individuals in the household ($p = 0.000$). Also of concern for disaster vulnerability is the presence of a household member with a disability. As expected, older households were significantly more likely to report at least one household member has a disability, whether it be mobility, hearing, vision, or cognitive disability ($p = 0.033$).

Table 3. Sample Household Characteristics, Elderly and Non-Elderly Respondents

	All (n = 629) Mean (SD)/Percent	Elderly (n = 237) Mean (SD)/Percent	Not Elderly (n = 392) Mean (SD)/Percent
Percent households all elderly	28.0	74.3	-
Percent households with a disability	18.9	23.2	16.3**
Household size	2.26 (1.22)	1.72 (0.61)	2.59 (1.37)***
Percent single family home	77.7	73.0	80.6**
Percent homeowners	89.7	96.2	85.7***
Percent insured[1]			
Homeowners insurance	84.1	89.8	80.0***
Renters insurance	6.1	3.4	8.0**
Flood	45.0	50.3	41.2*
Annual household income	$52,400 (22,800)	$48,300 (25,500)	$54,900 (25,700)***
Percent below 1.5 times poverty threshold	15.9	16.0	15.8
Wealth[1]***			
Less than $5,000	19.3	11.5	24.6
$5,001 - $10,000	15.0	10.3	18.1
$10,001 - $50,000	21.1	24.4	19.0
$50,001 - $100,000	11.9	16.0	9.1
Greater than $100,000	32.7	37.8	29.3

[1] These items were collected in the 2011 Wave (n=427)
* $p \leq 0.10$, ** $p \leq 0.05$, *** $p \leq 0.01$ (two-tailed test)

In contrast to age, household size, and disability indicators of vulnerability, elderly respondents seem to have less disaster vulnerability in terms of housing and economic resources. While less likely to live in a single family home ($p = 0.026$), elderly respondents are more likely to be homeowners ($p = 0.000$) and have insurance (homeowners $p = 0.006$; flood $p = 0.063$).

Economically, elderly respondents report lower annual household incomes ($p = 0.002$) but greater wealth reserves ($\chi^2 = 21.8$, $p = 0.010$). Finally, elderly and non-elderly respondents in our sample have approximately the same likelihood to be living below 150% of the 2010 poverty threshold.

General Social Capital

We collected general information related to social capital, which included the number of extended family in the community, organizational membership of household members, and frequency respondents speak with their neighbors (see Table 4). Recall that while larger social networks and greater connection to the community, in general, imply greater social support available during disaster, we expected that elderly respondents would report fewer network connections. On average, respondents report five extended family members living in their community. This result differs based on age category, with elderly respondents reporting significantly fewer extended family members living in their community (3.49 fewer) than non-elderly respondents ($p = 0.000$).

The less social capital available through in extended family connections for elderly respondents contrasts higher reported levels of non-familial social capital in the community through organizational membership and interaction with neighbors. A majority of elderly respondents (65%) report that they or someone in their household is a member of a church, nonprofit, or other community or civic organization in contrast to 57% of non-elderly respondents ($p = 0.039$). Elderly respondents also reported speaking with their neighbors more frequently than non-elderly respondents ($\chi^2 = 19.7$, $p = 0.001$). To illustrate, nearly a third of elderly respondents speak with their neighbors daily, compared to only one-fifth of non-elderly respondents.

Table 4. General Social Capital, Elderly and Non-Elderly Respondents

	All (n = 629) Mean (SD)/ Percent	Elderly (n = 237) Mean (SD)/ Percent	Not Elderly (n = 392) Mean (SD)/ Percent
Extended family in community	5.10 (0.42)	2.92 (0.30)	6.41 (0.64)***
Ordinal:			
None	40.9	46.8	37.2
1-2	16.2	15.2	16.8
3-6	21.1	24.5	19.1
7-100	21.8	13.5	26.8
Organizational membership	59.8	65.0	56.6**
Frequency talk with neighbors***			
Everyday	24.8	32.3	20.2
Few times a week	42.9	44.0	42.3
Few times a month	21.2	16.8	16.8
Once a month	6.3	3.9	7.7
Not at all	4.8	3.0	5.9

* $p \leq 0.10$, ** $p \leq 0.05$, *** $p \leq 0.01$ (two-tailed test)

Disaster-Specific Social Capital

To assess the availability of social capital resources during a disaster, we gathered information on the presence of social network connections that respondents believed they could rely on for assistance in the event of a disaster. This data provided social capital information by indicating the number of social network connections and the belief of what resources these connections could provide. We measured three separate types of resources that could be provided from social networks: evacuation sheltering, financial recovery assistance, and nonfinancial disaster recovery assistance. And because disasters have specific geographic and time components, we included questions about the location of these networks and the timeframe for the item measuring evacuation shelter assistance.

Evacuation Shelter Social Capital

Over the two waves of the survey, respondents indicated whether they had family or friends with which they could stay in the event of an evacuation, how long they could stay with these individuals, and how far they would need to travel to use these shelter resources. Table 5

shows the evacuation shelter networks for all respondents, then elderly and non-elderly respondents. Seventy-five percent of all respondents indicate that they have friends or family with which they could stay during an evacuation, and these results are similar among elderly and non-elderly respondents. Table 5 also shows that among those who have someplace to stay, nearly half of respondents have someplace they could stay for more than a month. Results, again, are similar between elderly and non-elderly respondents ($\chi^2 = 6.25$, $p = 0.283$).

Table 5. Evacuation-Shelter Social Capital, Elderly and Non-Elderly Respondents

	All (n = 629) Percent	Elderly (n = 237) Percent	Not Elderly (n = 392) Percent
Family or friend shelter	75.0	74.7	75.3
Length of network shelter			
1-2 days	5.7	5.1	6.1
3-6 days	13.8	15.3	12.9
1 week	16.3	15.8	16.6
2-3 weeks	10.2	12.4	8.8
1 month	10.2	13.0	8.5
More than 1 month	43.9	38.4	47.1
Location of network shelter[1]			
Less than 20 miles	6.5	9.0	4.7
20-60 miles	12.0	11.3	12.5
61-100 miles	16.3	17.3	15.6
More than 100 miles	65.2	62.4	67.2

[1] Results from 2011 Wave (n=325)
* $p \leq 0.10$, ** $p \leq 0.05$, *** $p \leq 0.01$ (two-tailed test)

In 2011, we asked respondents again if they had family or friends with which they could stay during an evacuation, and then asked about the location of these family or friends.[5] Specifically, we asked how many of the evacuation sheltering connections identified lived within 20 miles of the respondent because larger hurricanes would cause respondents to need shelter outside the community. A majority of all respondents, as well as a majority within each age group, indicate that they would travel more than 100 miles to reach these network resources ($\chi^2 =$

[5] Ninety-four respondents (22%) changed their response from the previous year. Results were similar to 2010, 76% of respondents indicated that they have family or friends to stay with, and the results are again similar across the two age categories (elderly = 73.5%; non-elderly 78.1%).

2.97, p =0.396) (Table 5). The small differences between the age groups is only noticeable at the shortest and farthest distances, with a slightly larger proportion of elderly respondents indicating that their evacuation shelter resources live within 20 miles of them and a smaller proportion reporting that they would travel over 100 miles.

Disaster Recovery Social Capital

To more fully understand the potential of social networks to reduce vulnerability to disaster, in 2011 we collected specific information about respondents' financial and nonfinancial assistance available from their social networks following a hurricane. Financial assistance included monetary gifts or loans, and nonfinancial assistance included childcare and helping with repairs, clean-up, or debris removal.

The distribution of the number of individuals respondents felt they could rely on for financial assistance following a hurricane was positively skewed, ranging from zero to 50 with mean of 2.45 and a median of two individuals (Table 6).[6] Non-elderly respondents indicated slightly more individuals that they could rely on for financial assistance than elderly respondents, but the difference was not statistically significant (p = 0.22).

For those who indicated that they had friends or family to ask for financial assistance following an event, we asked how many of those individuals live within 30 miles. Depending on the size of the disaster, network resources in close proximity may be overwhelmed with their own individual needs to assist others. The average proportion of the respondents' financial assistance network living near them was 0.47 for all respondents, and this geographic distribution of financial network resources differed little between the two age groups. Looking in more detail for those respondents who may be particularly at risk of network resources being

[6] One respondent indicated 200 individuals they could rely on for financial assistance. This response was recoded to 50, the next highest response to reduce its influence on the results.

overwhelmed in a disaster, a third of respondents indicated that *all* of those they could rely on for financial assistance live within a 30 mile radius, and over 42% indicate that half of the individuals they identified live near them.

As expected, respondents counted more individuals that they could rely on for nonfinancial assistance than financial assistance following a hurricane. On average, respondents identified approximately seven individuals for nonfinancial assistance.[7] Elderly and non-elderly responses differed statistically, with non-elderly respondents indicating an average of eight individuals and elderly respondents indicating only six ($p = 0.08$). Nonfinancial social network connections were much more likely to live within 30 miles of the respondent than financial network connections. On average, nearly 80% of the individuals that respondents identified as able to provide nonfinancial assistance lived near the respondent, which was similar across the two age groups. Looking more in detail at geographic location, 66% of respondents indicated that all of the individuals they could rely on for nonfinancial assistance live within 30 miles of them. Only 12% indicated that there was no one within 30 miles they could rely on for nonfinancial assistance.

Table 6. Disaster Recovery Social Capital, Elderly and Non-Elderly respondents[1]

	All (n = 394) Mean (SD)	Elderly (n = 157) Mean (SD)	Non-Elderly (n = 237) Mean (SD)
Individuals to rely on for financial assistance	2.45 (4.76)	2.08 (3.26)	2.69 (5.52)
Proportion that live within 30 miles	0.47 (0.03)	0.47 (0.05)	0.46 (0.04)
Individuals to rely on for nonfinancial assistance	7.26 (0.53)	6.16 (0.75)	8.01 (0.73)*
Proportion that live within 30 miles	0.80 (0.02)	0.81 (0.03)	0.79 (0.02)

[1] Data collected in Wave 2, age categories based on age in 2011.
* $p \leq 0.10$, ** $p \leq 0.05$, *** $p \leq 0.01$ (two-tailed test)

[7] Five respondents identified 100 individuals who could provide nonfinancial assistance. To maintain consistency across financial and nonfinancial measures, these were recoded to 50.

Predicting Evacuation Barriers and Hurricane Preparedness

We assessed the effect of elderly status and social capital resources on our two hurricane scales related to preparedness and evacuation. Table 7 shows summary statistics of the two dependent variables for all respondents and for each age group. The age groups differed significantly on both disaster scales, and both imply less vulnerability to disaster for elderly respondents. Elderly respondents reported fewer barriers to evacuation and completed more hurricane preparedness activities. We now move to predicting scores on each of these scales using elderly status and the social capital variables.[8]

Table 7. Summary Statistics of Evacuation Barriers and Hurricane Preparedness

	All (n = 427) Mean (SD)	Elderly (n = 181) Mean (SD)	Not Elderly (n = 246) Mean (SD)
Hurricane Preparedness	9.15 (3.98)	9.65 (3.78)	8.78 (4.09)*
Barriers to evacuation	54.3 (15.5)	52.8 (16.1)	55.5 (14.9)*

* $p \leq 0.10$, ** $p \leq 0.05$, *** $p \leq 0.01$ (two-tailed test)

Hurricane Preparedness

Table 8 shows the results of hierarchal ordinary least squares (OLS) regression of the Hurricane Preparedness Scale. Recall, higher scores on this scale indicate a greater number of completed preparedness activities. With hierarchal OLS regression we entered the independent variables in a series of groups, and the results represent the relative influence of each block on reported preparedness. Number of preparedness activities undertaken was affected by age group, two social capital variables, gender, living in or near poverty, and homeownership. Elderly respondents completed approximately one more preparedness activity than non-elderly respondents, and this effect remained statistically significant even after controlling for all other variables in the model. In terms of the social capital variables, nonfinancial social network connections and evacuation shelter connections positively affected the number of preparedness

[8] See end of paper for correlation matrix.

activities undertaken. Controlling of these variables had little impact on the magnitude of difference in reported preparedness between the age groups.

Table 8. Coefficients from OLS Regression Predicting Score on Preparedness Scale with Elderly, Social Capital, Gender, and Poverty[9]

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Elderly (1=yes)	1.159***	1.293***	1.322***	1.223***	1.189***	1.068***
	(0.392)	(0.390)	(0.390)	(0.388)	(0.386)	(0.385)
Nonfinancial network connections		0.0562***	0.0533***	0.0499***	0.0468**	0.0462**
		(0.0185)	(0.0185)	(0.0184)	(0.0183)	(0.0182)
Evacuation Network (1=yes)			0.733	0.746*	0.710	0.784*
			(0.451)	(0.448)	(0.444)	(0.442)
Female (1=yes)				-1.071***	-0.886**	-0.854**
				(0.390)	(0.394)	(0.391)
<150% Poverty Level (1=yes)					-1.503***	-1.242**
					(0.570)	(0.574)
Homeowner (1=yes)						1.823***
						(0.689)
Constant	8.671***	8.207***	7.657***	8.137***	8.325***	6.609***
	(0.255)	(0.295)	(0.449)	(0.478)	(0.480)	(0.805)
Observations	390	390	390	390	390	390
R^2	0.022	0.045	0.051	0.070	0.086	0.103

Standard errors in parentheses, *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Both gender and poverty had statistically significant effects on preparedness activities. Female respondents reported completing almost one fewer preparedness activities than male respondents, controlling for the other variables in the model. Living in or near poverty was negatively related to preparedness activities controlling for age, social capital, gender, and homeownership. As expected, households living at or below 150% of the poverty level undertook on average one fewer preparedness activity than households living above this threshold. In the final model, we controlled for homeownership. Respondents who own their home reported on average completing 1.8 more preparedness activities than other respondents

[9] These are parsimonious models. In results not shown, we assessed the effect of disability, employment status, household size, organizational membership, and extended family in the community as well as interaction terms related to poverty, elderly, and disability. Each of these added less the 0.005 to the R^2 and none were statistically significant, and Bayesian information criterion (BIC) results indicated use of the following parsimonious models.

controlling for all other variables in the model. Controlling for homeownership slightly reduced the effect of elderly status on preparedness, but it remained statistically significant.

Evacuation Barriers

Table 9 shows the results of OLS regression for the Evacuation Barriers Scale. Recall, higher scores on this scale indicate greater perceived barriers to evacuation and indicate relative position among different respondents in what they perceive has potentially hindering their ability to evacuate. Reported barriers to evacuation were related to living in or near poverty, two social capital items, and disability in the household, but less so to age group.

In model 1, we see that elderly respondents score on average about two points lower on the Evacuation Barriers Scale than non-elderly respondents, but the difference is not statistically significant. Model 2 shows that nonfinancial social network connections and evacuation shelter connections reduced the score on the scale, implying that these networks may assist with the ease of evacuation. As expected, evacuation shelter networks had the larger effect of the social capital variables, with the presence of at least one friend or family member to stay with during an evacuation reducing the score on the scale by nearly one-half a standard deviation, controlling for nonfinancial networks and age group. We must note that evacuation shelter connections were built into our Evacuation Barriers Scale through one of the 21 questions. The magnitude of this effect, though, cannot be entirely consumed within that question, as the question allows for only a five point variation in response and the effect seen here is a six point difference. Also, the addition of evacuation shelter connections to the model, increased the magnitude of the negative effect of elderly status, and it became marginally statistically significant (see Model 3). Thus even when comparing respondents with the same number of evacuation shelter connections, elderly respondents scored lower on our scale than non-elderly respondents.

Table 9. Coefficients from OLS Regression Predicting Score on Evacuation Barriers Scale with Elderly, Social Capital, Disability, and Poverty[10]

	Model 1	Model 2	Model 3	Model 4	Model 5
Elderly (1=yes)	-1.908	-2.398	-2.637*	-2.703*	-2.344
	(1.562)	(1.558)	(1.539)	(1.519)	(1.482)
Nonfinancial network connections		-0.205***	-0.182**	-0.174**	-0.150**
		(0.0738)	(0.0731)	(0.0722)	(0.0705)
Evacuation Network (1=yes)			-6.026***	-5.250***	-5.164***
			(1.782)	(1.774)	(1.728)
Disability (1=yes)				6.383***	5.238***
				(1.900)	(1.866)
<150% Poverty Level (1=yes)					10.19***
					(2.180)
Constant	55.72***	57.42***	61.94***	60.07***	58.57***
	(1.016)	(1.177)	(1.771)	(1.834)	(1.815)
Observations	390	390	390	390	390
R^2	0.004	0.023	0.051	0.078	0.128

Standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Finally, as expected, disability and living in or near poverty increased respondents score on the Evacuation Barriers Scale. Having a household member with a disability significantly increased the score on the scale by five points, even when controlling for age group, social capital, and poverty, which indicate these respondents felt evacuation would be more difficult than respondents without a household member with a disability. In terms of explaining the variance in the scale, living in or near poverty had the greatest impact on explained variance, nearly doubling the R^2, with respondents living at or below 150% the poverty level scoring 10 points higher on the scale.

Discussion

> It is important to understand the distinctions between these age groups because there are clearly differences among the elderly, as well as differences between older and younger persons in terms of health, function, and interaction in society. (Peek 2010: 156)

[10] These are parsimonious models. In results not shown, we assessed the effect of gender, employment status, household size, organizational membership, and extended family in the community as well as interaction terms related to poverty, elderly, and disability. Each of these added less the 0.005 to the R^2 and none were statistically significant, and BIC results indicated use of the following parsimonious models.

It has been consistently found that elderly persons are more likely to perish in a disaster, and research has sought to determine the cause of this differential vulnerability. Common explanations include poverty among older populations, physical and mental health limitations, and loss of social capital as individuals' age. Our preliminary analyses both confirm and conflict these general assumptions and point to distinctions to explore in future research.

Our results indicated that elderly persons in our sample may be less economically vulnerable to disaster impacts. Overall, they have larger financial resources, are more likely to be homeowners, and are more likely to have property insurance. Since economic resources are central to households being able to mitigate, respond, and recovery from disaster, our sample of elderly respondents are, on average, in a better situation to face disaster. If though, as Bolin and Klenow (1983) found, fixed incomes are detrimental to disaster recovery, the elderly respondents in our sample may still face difficulties following a hurricane. Also in terms of economic vulnerability, the results of our regression results indicate that living in or near poverty is a better predictor of preparedness undertaken and perceived barriers to evacuation than age. Thus poor households, whether or not headed by an elderly person, are at greater risk and face more difficulty protecting themselves.

In terms of social capital, elderly and non-elderly respondents differ both in general social capital and disaster-specific social capital. But general social capital was not useful in our regression models to predict preparedness activities or barriers to evacuation while our addition of disaster-specific measures of social capital was useful in these models. This result highlights the need to research specifics about the social capital of respondents as it pertains to the object under investigation, in this case disasters. For example, the types of network connections and resources required to find employment differs from those who would provide shelter during an

evacuation. Thus, specifying the resources available from social capital connections, not just the presence or absence of social capital, is key to disaster vulnerability research.

Disaster-specific social capital can be more crucial for elderly respondents that live in or near poverty, have a disability, or are isolated from family. For example, hurricane evacuees commonly stay with friends or family, which reduces the cost of evacuation sheltering and prevents individuals from having to stay in a public shelter. Thus staying with friends and family can be especially important to respondents of lower economic status, including the elderly on fixed incomes, as well as those with health and disability concerns since public shelter often lack medical and disability supplies. Age had little effect on respondents' likelihood of having friends or family that they could stay with during evacuation, nor on the timeframe available for sheltering or the distance to these shelter resources. While the elderly scored lower on our scale of evacuation barriers, the compounding effects of living in or near poverty and disability present in the household result in some of the elderly in our sample reporting greater perceived barriers to evacuation and indicating their increased need for support and assistance during a hurricane evacuation. Interestingly the effect of evacuation network connections was large enough to nullify the average effect of disability on perceived barriers. Thus, the presence of evacuation networks is crucial to households with a disability (who, in general, are more likely elderly) in reducing the vulnerability that the disability may generate.

Furthermore, the availability of disaster-specific social capital is important to those who live alone or in households with only other elderly persons and have few extended family members in their communities. In general, larger households can have positive and negative effects on disaster vulnerability by either increasing the number of individuals who require care and attention (e.g. having many children in the household) or, conversely, increasing the

likelihood of hearing disaster warnings, increasing the number of people who are able to assist in preparation or recovery from a disaster, and increasing the social capital the household could draw upon in a disaster. Our elderly population lived in households with fewer people and commonly lived in households made up exclusively of other elderly persons. This result, along with greater incidence of disability, suggests that elderly persons will be more reliant on social capital in the broader community for assistance during and after a hurricane. Because our results also indicated that the type of social capital connections differ for elderly and non-elderly respondents with elderly respondents having greater organizational and neighborly interaction than non-elderly respondents, the differential effect of these types of connections of social assistance during disaster deserves further investigation.

Our results are limited because of the nature of our sample and study design. This three year study was designed to capture actual evacuation of a subset of the respondents during one of the three study years. The first two years produced only one, small evacuation of less that 20 of our respondents from North Carolina during Hurricane Irene. Thus because we have not measured the actual impact of a hurricane on these respondents, our results can only point to potential vulnerabilities of our respondents. Furthermore, our sample is highly educated, mostly white, and of higher economic status than the general population of these areas. The small number of minority respondents precluded us from even including this variable in our statistical models. From the literature we know that the elderly experience and social capital differs greatly based on race. Thus, inferential results herein should be evaluated in light of this sample.

Vulnerability is embedded in complex social relations and processes and is best viewed as a social problem that requires social solutions (Phillips and Fordham 2010). Our results support the complex nature of disaster vulnerability and that complex interactions between

various social, demographic, and economic forces affect vulnerability. We conclude that the effect of age on disaster vulnerability should be viewed in light of how the elderly are embedded in broader social institutions including economic and community institutions, and how subsets of the elderly that face declining health or limited resources will face disproportionate impacts of disaster without greater community and social support. In the U.S. today, emergency services organizations should not assume that family or friends will be present or able to aid elderly individuals in disaster. Based on our findings that elderly respondents social capital is strongest when measured by organizational involvement and interaction with neighbors, buttressing elderly individuals' ability to respond and recover from disaster should involve community organizations and campaigns to support neighborly involvement to prevent disproportionate impacts for this demographic (Browning et al. 2006; Cannuscio, Block, and Kawachi 2003).

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Table 10. Correlation Matrix Disaster Preparedness and Barriers to Evacuation with Social Capital Variables

	Prepared Scale	Barrier Scale	Financial	Nonfinancial	Evacuation	Extended Family	Organization Member
Disaster							
Prepared Scale	–						
Barrier Scale	-0.050	–					
Disaster Social Capital							
Financial	0.140***	-0.017	–				
Nonfinancial	0.133***	-0.132***	0.500***	–			
Evacuation	0.059	-0.112**	0.120**	0.111**	–		
General Social Capital							
Extended Family	-0.031	0.007	0.014	0.049	0.001	–	
Organization Member	0.056	-0.065	0.053	0.082	0.044	0.020	–
Talk with Neighbors	-0.129***	0.079	-0.083*	-0.072	-0.062	0.063	-0.115***

* $p \leq 0.10$, ** $p \leq 0.05$, *** $p \leq 0.01$ (two-tailed test)

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