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Break-up of New Orleans Households after Hurricane Katrina

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Abstract

Theory and evidence on disaster-induced population displacement have focused on individual and population-subgroup characteristics. Less is known about impacts on households. I estimate excess incidence of household break-up due to Hurricane Katrina by comparing a probability sample of pre-Katrina New Orleans resident adult household heads and non-household heads ($N = 242$), traced just over a year later, with a matched sample from a nationally representative survey over an equivalent period. One in three among all adult non-household heads, and one in two among adult children of household heads, had separated from the household head 1 year post-Katrina. These rates were, respectively, 2.2 and 2.7 times higher than national rates. A 50% higher prevalence of adult children living with parents in pre-Katrina New Orleans than nationally increased the hurricane's impact on household break-up. Attention to living arrangements as a dimension of *social vulnerability* in disaster recovery is suggested.

Keywords

living arrangements; marital separation; multigenerational relations

More than three decades ago, Bolin (1976, p. 267) lamented that “The greater part of disaster research has focused on complex organizations, the community, or individuals with the family as a unit being given only cursory attention.” Tierney's (2007) recent survey of the field of disaster research indicates that this is still largely true, even as more attention to family processes has occurred through an increased emphasis on gender (e.g., Morrow, 1999). The literature on the sociology of disasters provides the insight that social impacts of natural disasters differ according to pre-disaster socioeconomic conditions, which describe the population's degree of *social vulnerability* (e.g., Cutter, Boruff, & Shirley, 2003). In the present study, I consider household structure as a social vulnerability characteristic. I estimate the effect of Hurricane Katrina in 2005 on the break-up of New Orleans households following Katrina, considering both the incidence of break-up by household structure and the distribution of those household structures in pre-Katrina New Orleans.

The data and methodological challenges of estimating an elevated incidence of household break-up attributable to the hurricane are considerable. In addressing them, I apply a case-control analytical framework to cases from a survey sample designed to be representative of New Orleans households in August 2005 (the Displaced New Orleans Residents Pilot Study, DNORPS; Sastry, 2009b) and to controls from an ongoing national panel survey of households (the Survey of Income and Program and Participation, SIPP; U.S. Census Bureau, 2010) over an equivalent period. In addressing the role of the pre-Katrina household structures, I also use the 2005 American Community Survey data (U.S. Census Bureau 2007b) to compare New Orleans and the United States generally and to evaluate the representativeness of the analytical DNORPS and SIPP samples of New Orleans and U.S. household structures.

Background and Conceptual Framework

Hurricane Katrina's impact on New Orleans began with what Fussell and Elliot (2009, p. 383) described as "the largest, most complete urban evacuation ever to occur on U.S. soil." Nigg, Barnshaw, and Torres (2006, p. 113) described size of the evacuation of the Gulf Coast areas in the path of Hurricane Katrina as numbering 1.3 million people, and remarked on two additional aspects of the Katrina evacuation that made it unprecedented: the sending of evacuees to distant, out-of-state shelters and the duration of the evacuation into "weeks or months" instead of the usual duration measured in "days or a couple of weeks at most" (p. 121). Quarantelli (2006, p. 3) described Hurricane Katrina not as a disaster but as a catastrophe, one of the characteristics of which is that the scale of physical destruction makes it impossible for displaced residents to obtain shelter with nearby relatives and friends. He included as catastrophes both Hurricane Katrina's impact on New Orleans and Louisiana and Hurricane Andrew's impact on Miami and southern Florida in 1992. Hurricane Andrew, however, had relatively little long-term impact in terms of numbers of permanently displaced people. S. K. Smith and McCarty (1996) estimated that 353,300 residents of the main county affected by Hurricane Andrew were at least temporarily displaced from their pre-hurricane homes, but that only 39,200 left the county permanently because of the storm, with as many as half of these moving only as far as to a neighboring county. In contrast, Hori, Schafer, and Bowman (2009, p. 56) estimated that as many as 247,000 people—more than half of the pre-Katrina population of Orleans Parish (the city of New Orleans)—were still living outside the parish (the Louisiana equivalent of a county) almost a year after Katrina struck. Of these, 163,000 individuals had moved outside the 18-parish region of southern Louisiana that included neighboring Baton Rouge. Displaced individuals from New Orleans and from the entire storm-affected area were more likely to be from the lower income population (Frey, Singer, & Park, 2007; Groen & Polivka, 2010; Sastry, 2009a). This was due in part to the greater destruction of disadvantaged New Orleans neighborhoods (Baade, Baumann, & Matheson, 2007).

The distinctive nature of movement out of New Orleans after Katrina has challenged existing theoretical models of disaster research. Social vulnerability framework (e.g., Cutter, et al., 2003) has provided an important means for understanding the differential social impacts of natural disasters, including Hurricane Katrina (Yarnal, 2007). According to this framework, the social impacts of natural disasters need to be understood not only in the light of the physical strength and destructiveness of natural hazards, but also according to pre-disaster socioeconomic conditions. Myers, Slack, and Singlemann's (2008) test of the applicability of the social vulnerability thesis to outmigration (long-term displacement) following hurricanes Katrina and Rita (also in 2005) included both household characteristics such as poverty and individual characteristics such as the percentage of elderly and very young persons in the county population. No family or household structure characteristics, however, were included. They found the economically disadvantaged percentage of the county population to be a significant predictor of net outmigration after controlling for housing damage, but found no significant associations with either the percentage of elderly or of very young persons. Further, Groen and Polivka (2010) found in analyses of individual-level data that older individuals were more likely to return to their pre-Katrina residences.

Family and household structure occupy a marginal place in most disaster research conducted under the social vulnerability framework. No family or household structure elements were included among the 11 primary dimensions of social vulnerability identified by Cutter and colleagues (2003) and subsequently examined by Cutter and Emrich (2006) in their study of Gulf Coast communities' exposure to differential impacts of Hurricane Katrina. The relative inattention to families and households may be due to the emphasis of this literature on

disaster preparedness and evacuation. In relation to the evacuation process, Donner and Rodriguez (2008) considered single-mother families among possible characteristics of social vulnerability, but Brezina (2008) found no evidence that being a single mother decreased the likelihood of pre-storm evacuation from New Orleans. Haney, Elliot, and Fussell (2007) described the splitting of families as having occurred with substantial frequency in the evacuation following Hurricane Katrina, but little is known about family and household intactness following the initial evacuation. The individual has been the typical unit of analysis in studies of displacement due to Hurricane Katrina.

Family and household structure may be a more important social vulnerability characteristic in the recovery and reconstruction phases following a disaster (Peacock, Dash, & Zhang, 2007) than during the evacuation phase. In recovery and reconstruction, the pre-disaster family and household units may return intact to their pre-disaster residences, reconstitute pre-disaster households in new residences inside or outside the affected area, or split into multiple post-disaster living situations. Unsurprisingly, physical destruction of housing was a major determinant of who was displaced from New Orleans. Sastry (2009a) found that almost three quarters of pre-Katrina residents from unflooded neighborhoods were again living in New Orleans a year later, whereas only two fifths of those from neighborhoods that experienced flood depths of more than 4 feet had returned. This points to a potentially greater strain on the intactness of households from the most physically damaged neighborhoods.

Because extended-family households, in particular, are often formed and maintained due to strong material needs (Rendall & Speare, 1995), pre-disaster household structure may reasonably be hypothesized to be a dimension of social vulnerability in the recovery and reconstruction phases. Two demographic groups are more likely to be in extended-family households due to the need for, and benefits of, intrahousehold resources: young adults and older people. Among elders, unmarried women (especially minority unmarried women) are the largest group to benefit from living with relatives (Angel, Jimenez, & Angel, 2007; Waite & Hughes, 1999). Among younger adults, single mothers, and minority single mothers in particular, have been identified as forming extended-family households due to need (Hofferth, 1994). The dependence of low-income young adults, with or without dependent children, on extended-family households is emphasized in Wasson and Hill (1998) and Wright, Caspi, Moffitt, and Silva's (1998) analyses of "doubled-up" housing as a frequent precursor to homelessness. The direction of needs and exchange relationships between adults in extended-family households, moreover, is not uniform. Younger adults may either receive or provide care and economic resources, or both, to and from parents (Choi, 2003).

Extended families are normally at highest risk of break-up (Richards, White, & Tsui, 1987), and physical displacement occasioned by a disaster or catastrophe is likely to exacerbate this risk. The processes of post-evacuation housing assistance are expected to have a major impact on family intactness in post-disaster recovery and reconstruction for lower income households. The general finding in the literature is that recovery and reconstruction programs disadvantage poorer residents (Fothergill & Peek, 2004). Renters, including those in public housing, are often least well-provided for in recovery programs, while poorer home owners are less likely to receive insurance payouts sufficient to rebuild than are higher income home owners. These processes all reduce the ability of lower income individuals and families to return to and resettle in the area from which they were displaced. Kamel and Loukaitou-Sideris (2004) found that inequality in the provision of housing assistance across neighborhoods resulted in greater displacement from, and net depopulation of, the more economically disadvantaged communities affected by the 1994 Northridge earthquake in Los Angeles. The experience of family evacuation, temporary housing, and recovery of

permanent housing following Hurricane Andrew is also suggestive of how family structure may have been involved in the amplification of pre-existing social inequalities. Morrow and Enarson (1996) describe a lack of accommodation of extended-family households in emergency housing in a recovery program that was tailored to the nuclear-family model. Morrow (1999, p. 6) nevertheless describes three-generation households headed by women as being “the last families remaining in the temporary trailers nearly two years after Andrew.”

In the context of the greater physical and economic damage wrought by hurricanes Katrina and Rita, difficulties in recovering previous housing or finding suitable new permanent housing (Katz, Liu, Fellowes, & Mabanta, 2005) may have made extended-family households especially prone to dissolution. A process of depopulation of the most economically disadvantaged New Orleans neighborhoods occurred, analagous to that described by Kamel and Loukaitou-Sideris (2004), but on a much larger scale (Baade et al., 2007). Even when a family’s residence was little damaged, moreover, the wider damage to the community that included loss of public services (Groen & Polivka, 2010) and local job losses may have put strong pressures on the intactness of extended-family households. For example, adult children and parents living together may have split up if the adult children’s jobs were no longer available in the disaster-hit location, forcing them, but not their parent(s), to relocate outside the region.

Disaster-induced population displacement may put pressure on the intactness not only of extended-family households but also of nuclear-family households. Temporary separation of one parent or partner may occur while damage to housing or neighborhood infrastructure (e.g., schools) is repaired. In some cases, the disaster may precipitate the dissolution of a marital or cohabiting unit. Economic pressures are known to increase the likelihood of dissolution of marital and cohabiting unions in non-disaster circumstances (White & Rogers, 2000). Economic pressures due to difficulties finding jobs after Katrina may have increased pressure on displaced New Orleans couples’ intactness. Labor-market outcomes were worse for those who were displaced from New Orleans and other areas due to Katrina than among those who quickly moved back to New Orleans (Zottarelli, 2008; Zissimopoulos & Karoly, 2010). Finally, psychological stresses on individuals and families (e.g., Weisler, Barbee, & Townsend, 2007) are also potentially family-disrupting effects of disasters.

Other social dimensions, however, might have made the New Orleans households resistant rather than vulnerable to break-up. New Orleans has a history as an economically disadvantaged community, but with strong geographical and cultural roots (Falk, Hunt, & Hunt, 2006). While economic disadvantage makes for greater vulnerability to uprooting due to lack of economic resources to rebuild, a strong community history offers a psychosocial motive for greater efforts by members of the community to recover their physical place together. Sastry (2009a) found that being born in Louisiana was associated with a higher likelihood of intending to return to New Orleans among those displaced. Another positive force for the intactness of households is seen in research emphasizing the resilience of the family in the presence of severe outside pressures such as natural disasters and catastrophes. The concept of “kin embeddedness” was introduced early to the disaster literature by Bolin (1976) in his study of displacement following a catastrophic flood in Rapid City, South Dakota. In both this and Erikson’s (1976) landmark study of environmental disaster in upstate New York, the primacy of the family unit was found to increase as other community structures broke down either due to physical destruction or under community conflict in the recovery and reconstruction process.

From the preceding discussion on families and households in disasters generally, and in New Orleans following Hurricane Katrina in particular, I derive the following four hypotheses:

Hypothesis 1. Hurricane Katrina was associated with an elevated (excess) incidence of break-up of New Orleans households compared to that experienced by similar households in U.S. metropolitan areas as a whole;

Hypothesis 2. Excess break-up occurred in both nuclear and extended families in New Orleans;

Hypothesis 3. Excess household break-up occurred both for residences with major physical damage and for residences with little or no physical damage; and

Hypothesis 4. A greater prevalence of extended-family living arrangements in pre-Katrina New Orleans than nationally increased the incidence of excess household break-up.

METHOD

This study takes advantage of a unique survey data source, the Displaced New Orleans Residents Pilot Study (DNORPS). The DNORPS was designed as a survey of households from a stratified probability sample of pre-Katrina dwellings in the city of New Orleans (Orleans Parish) just before Katrina struck. The survey was conducted in the fall of 2006, 13 to 15 months after Katrina. Telephone interviews were supplemented by mail and in-person data collection. The DNORPS collected information on all pre-Katrina household members, including their location at the survey date. A total of 344 dwellings were sampled for the DNORPS, 325 of which were found to be eligible for interview (the dwelling was occupied in August 2005 by at least one resident who survived to the survey date in 2006). Of these, completed surveys were conducted for 147 households, giving an adjusted response rate calculated at 51% after subsampling outstanding cases for the final stage of fieldwork. This compares favorably with the 35% to 39% response rates of the only other survey effort to have attempted to contact pre-Katrina residents of Orleans Parish, including those who had moved outside the immediate region (Henderson, Sirois, Chen, Airriess, Swanson, & Banks, 2009, p. 75). Multivariate analyses of the probability of nonresponse by survey operational characteristics, including flood-depth strata, and by area sociodemographic characteristics as assessed from 2000 U.S. Census block or block-group statistics, were conducted by Sastry (2009b). These revealed no statistically significant sociodemographic patterns of nonresponse, but indicated that, controlling for sociodemographic characteristics, individuals from residences in the high flood-depth stratum (more than four feet) were less likely to respond (odds ratio of 0.29 relative to the no-flood stratum). Because flood depth and associated housing damage is associated with higher rates of household break-up, I expected this form of nonresponse bias to exert some downward bias on my estimates of the overall effect of Hurricane Katrina on household break-up.

I used the 2005 American Community Survey (ACS; University of Minnesota, 2009) to describe household and family living arrangements in New Orleans before Katrina and to place them in a national context. The ACS also allows for checks of the DNORPS' representativeness with respect to the living arrangements of New Orleans households. There is unfortunately no longitudinal equivalent of the ACS with sufficient overall sample size to allow for estimates for geographical areas as small as a city or metropolitan area, for example, for New Orleans before Hurricane Katrina. As a next-best option, I use a case-control analytical framework to estimate excess household break-up by comparison to a national sample of sociodemographically similar individuals and households.

The Case Sample: The Displaced New Orleans Residents Pilot Study

The DNORPS includes individuals in households of all sizes. One-person households, however, are by definition not at risk of household break-up, and are therefore excluded from the analyses. Of the 110 households containing at least two individuals in August 2005, just before the mass evacuation of New Orleans, 101 included at least two adults (aged 18 and over). Each household is designated to have one head, who is “the individual in whose name the house in New Orleans was owned or rented” (DNORPS questionnaire). The 141 non-household head adults in those households for which complete data were available (two households had to be dropped, as described below) constitute the case sample for the multivariate analysis of break-up. Correlated break-up outcomes between non-household heads from the same pre-Katrina household are adjusted for use in the statistical analysis.

The moves of individual household members were asked about in several ways in the DNORPS. First, the roster provided a check box to identify whether each member still lived with the August 2005 household head at the 2006 survey date. I used this check box as the main source of household break-up information. Additionally, for the first five members on each household roster, the following information was collected: whether the individual was living in the pre-Katrina residence at the survey date, where the person was currently living if not in the pre-Katrina residence, place of evacuation, and place where the individual spent the most time since Katrina. These questions allow for cross-checks on the roster check-box question and for corrections to be made where needed. I use the term *displaced* to refer to those individuals who were not living in their pre-Katrina residence at the survey date. Household break-up, and the separation of non-household head adults from the household head, therefore involves the displacement or death of at least one member of the pre-Katrina household or household head-nonhead pair. A household or household head-nonhead pair remained intact if no one or neither adult was displaced or if all or both were displaced but were again living together at the survey date. A major advantage of these definitions of displacement based solely on change of residence is that they allow the moves associated with the break-up of New Orleans households or head-nonhead pairs following Katrina to be compared to a national sample that was not subject to the particular conditions of storm-induced displacement. Deaths of household members accounted for only a small fraction (3%) of all break-up events; only two older non-household head adults (one spouse and one sibling of two household heads) died among the 141 adult non-household heads and 101 household heads in the DNORPS sample.

I classified residences into *habitable* and *uninhabitable* through a combination of their location in the high flood-depth stratum (all coded as uninhabitable) and responses to the question, “What was the extent of damage to your housing from Katrina and flooding?” I classified as uninhabitable those housing units in medium flood-depth and no-flood strata for which the respondent reported the residence had been destroyed or rendered uninhabitable (“Damaged so badly that you couldn’t live in it”). Almost all housing units in the high flood-depth stratum would also have qualified as uninhabitable based on the condition of the individual units.

The Control Sample: The 2004 Panel of the Survey of Income and Program Participation

I use as a control sample a national panel survey, the 2004 panel of the Survey of Income and Program Participation (SIPP) over a similar period as the DNORPS: the 16 months from Wave 1 of SIPP in 2004 to Wave 5. To evaluate the sensitivity of our results to the SIPP households in geographical areas different from that of the New Orleans sample, I conducted analyses alternately using only the SIPP’s metropolitan area households in the three Gulf Coast states of Alabama, Louisiana, and Mississippi. After finding no substantial

differences in migration and break-up between the Gulf Coast states and the national sample of metropolitan areas (described below), I included all households in U.S. metropolitan areas in the national sample for the multivariate, propensity-score matching analysis. This had the advantage of matching New Orleans individuals to the largest possible number of observationally similar individuals in the SIPP.

The head of household in the SIPP is defined as it is in the DNORPS, as the person in whose name the house was owned or rented. The SIPP attempts to survey all adult members of the Wave 1 household in subsequent waves at intervals 4 months apart. This allows for potentially multiple informants of household break-up. I took advantage of this to code a split between a household head and an adult non-household head in the SIPP when either the head or another adult individual (but not both) was lost to follow-up (attrited), or when both were followed but were living in different residences 16 months later. Out of 27,432 SIPP 2004 panel adults who were non-household heads, 1,539 (5.6%) attrited, while the household head remained in the survey, and 446 (1.6%) remained in the survey while the household head attrited. These 1,985 cases where one but not both attrited accounted for two thirds (65%) of all coded splits between the household head and a specified non-household head adult. An additional 1,064 cases in which both the household head and non-household head remained in the survey but were living in different residences 16 months later accounted for the remaining 35% of coded splits. There were 4,550 cases (16.6%) in which both the non-household head and the household head attrited between Wave 1 and Wave 5, and so for which no information is available on household intactness. These cases of household attrition were excluded from the analysis. They may plausibly have a higher rate of break-up than households in which either the non-household head or the household head was followed. If so, this would have the effect of downwardly biasing rates of break-up in our national estimates, to an upper bound of those 16.6% of cases in which both the household head and adult non-household head were lost to follow-up. This potentially biases upwards our estimates of the effects of Hurricane Katrina on household break-up. The slightly longer time between Wave 1 and 5 in the SIPP (16 months) than in the DNORPS (13 to 15 months) will offset this bias to some extent. There may also be a compensating bias towards greater nonresponse for nonintact households in the New Orleans (DNORPS) sample, analogous to attrition bias in the SIPP. Both the absolute and relative magnitudes of bias in the SIPP and DNORPS are unfortunately difficult to estimate due to the lack of suitable standards for comparison.

Multivariate Analysis

I used one-to-many propensity-score matching (Smith, H. L., 1997) between the case and control samples to estimate the overall effects of experiencing Hurricane Katrina on a given individual's splitting from the household head, and to estimate how this "Katrina effect" on break-up differs by the adult individual's spousal versus extended-family relationship to the household head and by post-Katrina housing habitability. Unlike a multivariate regression analysis, the propensity-score matching estimates are directly comparable to bivariate estimates of simple differences in means or proportions. In the present case, this is the difference between the proportions of non-household head adults in New Orleans and nationally who split from the household head. Because the propensity-score estimator operates by applying the distribution of characteristics of New Orleans residents to the national sample, the interpretation is analogous to that from a directly standardized demographic rate estimator (e.g., Smith, D. P., 1992) in which New Orleans provides the "standard" population whose distribution of characteristics is applied to the national sample of households. In place of using the distribution represented by cell proportions, however, the propensity estimator reweights the national sample on an estimate of the probability ("propensity") that an individual of a given set of characteristics will be in the DNORPS

sample given that he or she is in either the DNORPS or the SIPP sample. The major advantage of the propensity score over a simple demographic standardization estimator is that it solves the problem of dimensionality with multiple explanatory variables.

Sample-size restrictions in the DNORPS nevertheless mean that the number of explanatory variables and variable categories used in the matching procedure needs to be minimized. I limited them to relationship to household head, the non-household head's age, education, and employment status, the race of the household head, and whether the housing unit was owned or rented. Two non-household head cases were dropped due to missing education or employment status. For non-household heads other than spouses, the expected direction of association with splitting from the household head is based on life course stage and resources available for economic independence. Younger non-household heads are expected to have a greater propensity to split off from the household head (i.e., leave home). More educated and employed non-household heads are expected to have a higher propensity to split off from the household head due to their greater resources with which to achieve economic independence outside the family. Being from a household with an African American household head or a household head who was renting is expected to be associated with greater disadvantage and therefore with lower propensity to split off. Given the relative fragility of extended-family households (Richards et al., 1987), nonspousal relatives or nonrelatives of household heads are expected to split off with greater frequency than are spouses.

As a test of robustness of the propensity score estimator, I also compared the results to those from a logistic regression that pooled the DNORPS and SIPP observations and interacted presence of the observation in the DNORPS. This provided an alternate test of the study's hypotheses by whether the DNORPS coefficient is statistically significant in the expected positive direction for likelihood of break-up. Although regression parameter and propensity-score estimator metrics are not directly comparable, no qualitative differences in results of the hypothesis tests were found in the pooled logistic regression. These results and additional details on the propensity-score methodology used here are given in Rendall (2009).

RESULTS

I first considered the forms of household structure in pre-Katrina New Orleans versus household structures nationally, taking adult non-household head individuals as the units of analysis (see Table 1). The distribution of non-household head adults' relationships did not differ statistically between the ACS and DNORPS data sources in New Orleans and differed little substantively between the ACS and SIPP data sources nationally. Between New Orleans and nationally, however, the differences were large. Fewer non-household heads were spouses in New Orleans (43% and 42% respectively in the DNORPS and ACS) than nationally (55% in the ACS and 59% in the SIPP). Children of household head, in contrast, constituted around 30% of non-household head adults in New Orleans versus 20% nationally. This is an important result for the study's examination of the role of the distribution of pre-Katrina household structures in New Orleans in overall vulnerability to household break-up (Hypothesis 4).

I next present descriptive statistics on the intactness of households of two or more people, in New Orleans and nationally, by whether the entire household or any of its members moved, differentiating New Orleans households by whether the household's residence was habitable or uninhabitable after Hurricane Katrina (see Table 2). Results nationally are seen to be very similar to results restricted to the three Gulf Coast states. Overall, three quarters (75.5%) of metropolitan area households nationally remained intact and in the same residence, versus

only 32.3% in New Orleans. A further 10.3% of households nationally moved as an intact unit into a new residence, versus 30.9% in New Orleans. Thus 85.8% of households nationally remained intact versus 63.2% of New Orleans households. Cases of households breaking up with all members moving, but to more than one new residence, made up only 2.1% of all households nationally contrasted to almost a quarter (23.0%) of New Orleans households. Adding to this 23.0% the 30.9% of completely displaced households that remained intact, 53.9% of New Orleans households with two or more people were displaced entirely. Adding the 13.9% of households in which at least one, but not all, household members moved from the pre-Katrina residence, as many as two thirds (67.8%) of New Orleans households experienced the displacement of at least one individual following Hurricane Katrina. Nationally, only 24.0% of households of two or more people had at least one member move over a similar period.

Damage to the New Orleans residence was strongly correlated with displacement; this affected how household break-up occurred, how households remained intact, and how many households experienced break-up. From residences that were rendered uninhabitable by Hurricane Katrina, 75.0% of households were displaced entirely—that is, no pre-Katrina household members lived in the residence just over a year later. Among habitable residences, only 12.5% of households were displaced entirely. The modal outcome for households from uninhabitable residences was to remain intact but in a new residence (42.7%); for households from habitable residences it was to remain intact in the pre-Katrina residence (63.9%). The next most common outcome for households from uninhabitable residences was a break-up in which all members moved but not all to the same new residence (32.3%); for households from habitable residences it was a break-up in which at least one member remained in the pre-Katrina residence (23.5%). Overall, 41.2% of households from uninhabitable residences broke up versus 28.2% of households from habitable residences.

Multivariate Analysis of Non-Household Head Individuals' Splitting from the Household Head

Sample-weighted comparisons of the characteristics of the 141 non-household head adults in the DNORPS analytical sample with the 22,774 non-household head individuals in the U.S. metropolitan area sample (the SIPP) are given in Table 3. The distributions by age, education, employment status, and home ownership were similar between New Orleans and U.S. metropolitan areas. The two characteristics that differed significantly were the proportion of African American adults (60.0% in New Orleans versus 10.8% in the United States generally) and the relationship to head (non-household head New Orleans adults were more likely to be children of the household head or in another nonspousal relationship to household head). Within New Orleans, the hurricane's impact was not neutral for race or socioeconomic status: Non-household head individuals from uninhabitable residences were more likely to be African American and to have less education. Among non-household heads from habitable residences, only 29.6% had an African American household head, versus 75.0% of non-household heads from uninhabitable residences; 70.4% of non-household head adults from habitable residences had some years of college education, versus 50.1% from uninhabitable residences.

Bivariate associations of being a New Orleans resident with splitting from the household head and multivariate, propensity-score estimates of the effect of experiencing Hurricane Katrina on a non-household head adult's splitting from the household head (after controlling for characteristics described in Table 3) are presented in Table 4. Overall, one third (33.1%) of New Orleans non-household head adults were living separately from the pre-Katrina household head after the 13 to 15 months since Hurricane Katrina struck, compared to a 12.9% incidence nationally over a similar period (16 months). After

controlling for sociodemographic characteristics, including relationship to household head, 18.1% of the New Orleans break-up incidence can be attributed to Hurricane Katrina and its aftermath. This is smaller than the difference between the New Orleans and national proportions ($33.1\% - 12.9\% = 20.2\%$), implying a larger propensity for break-up among non-household head adults in New Orleans than nationally even before Hurricane Katrina. After accounting for this higher propensity by matching on the characteristics of New Orleans non-household heads, a 2.2 times higher incidence of break-up ($33.1 / [33.1 - 18.1] = 2.2$) is seen.

Among all non-household head individuals whose residences became uninhabitable, 38.2% were no longer living with the household head in late 2006, with two thirds of those break-ups attributable to Hurricane Katrina (24.8% of the group). This implies a 2.9 times higher rate of break-up than nationally ($38.2 / [38.2 - 24.8] = 2.9$). For non-household heads who were in residences still habitable after Katrina, almost twice as many as nationally (22.8% versus 12.9%) separated from the household head. The estimate of 9.2% attributable to Katrina for residents of habitable units was marginally significant in a two-tail test of difference from zero, for a magnitude of 1.7 times the national incidence of break-up.

Half (52.8%) of adult children of heads of pre-Katrina households separated from the household-head parent following Hurricane Katrina; the majority of these (33.5%) were attributable to Katrina and its aftermath. In this case, the multivariate effect differs little from the simple bivariate difference in proportions between New Orleans following Katrina and nationally over a similar period. Both imply a 2.7 times greater likelihood that an adult child of the head of a New Orleans household would separate from the household head compared to an adult child of a household head nationally. In contrast, no statistically significant difference in the splitting-off of spouses is found, even though the point estimate of 2.6% was in the expected direction.

DISCUSSION

A catastrophic natural disaster such as Hurricane Katrina for the city of New Orleans will have major impacts not only on individuals but also on families and households. In the present study, I compared the household structure dynamics between a probability sample of pre-Katrina New Orleans residents traced just over a year after the hurricane and a matched sample from a nationally representative survey over an equivalent period. To maximize the statistical power of the New Orleans observations, I used propensity-score estimation with one-to-many matches to the national panel survey observations. I further used American Community Survey data to compare pre-Katrina New Orleans and national household structures.

Two thirds of pre-Katrina households of two or more individuals saw at least one member move from the pre-Katrina residence. In this context, it is unsurprising that the incidence of separation between household head and non-household head adults of all types was 2.2 times the national rate after matching on individual and household sociodemographic characteristics and on relationship between the household head and non-household head. This provides strong support for Hypothesis 1 that Hurricane Katrina was associated with an elevated (excess) incidence of break-up of New Orleans households compared to that experienced by similar households in U.S. metropolitan areas as a whole.

The incidence of separation between household head and non-household head adults was 2.9 times the national rate when the pre-Katrina residence was rendered uninhabitable, and 1.7 times the national rate when the pre-Katrina residence was still habitable. This latter result provides some support for Hypothesis 3 that excess break-up occurred both for

residences with major physical damage and for residences with little or no physical damage after the storm, indicating that physical damage alone is unlikely to account for these elevated rates of household break-up. Loss of employment opportunities and community infrastructure (Baade et al., 2007; Groen and Polivka, 2010) likely also played a substantial role.

Hypothesis 2, that excess break-up occurred to both nuclear and extended families in New Orleans, was not supported, as no statistically significant difference in marital separation or dissolution was found between the New Orleans and matched national samples. This may have been due to a lack of statistical power in our New Orleans sample to detect a still relatively rare event, occurring for approximately 1 in 10 New Orleans married couples.

A strong Hurricane Katrina effect on household break-up, however, was found for extended-family households. Half of all adult children of household heads were no longer living with their pre-Katrina household head parent just over a year later in 2006. Their incidence of separation was 2.7 times higher than the matched national sample. Coresident adult children and their parent(s) were especially common extended-family types among pre-Katrina New Orleans households, and were 50% more prevalent than in households nationally. The overall rate of household break-up of 2.2 times the national rate was therefore not only due to higher probabilities of break-up conditional on pre-Katrina living arrangements but also due to the particular configuration of living arrangements in New Orleans favoring extended-family households. This not only provides strong support for Hypothesis 4, that the greater prevalence of extended-family living arrangements in pre-Katrina New Orleans than nationally increased the incidence of excess household break-up, but also has implications that are central to the theoretical framework of the investigation. Because extended-family households are typically formed and maintained due to economic and physical need (Rendall & Speare, 1995; Waite & Hughes, 1999), I argue that household structure may therefore appropriately be considered a dimension of pre-disaster social vulnerability. The unequal manner in which New Orleanians' needs were provided for in pre- and post-disaster planning and policy implementation (Freudenburg, Gramling, Laska, & Erikson, 2008; Katz et al., 2005) may also have played a substantial role in amplifying socioeconomic and racial inequality through the mechanism of household break-up.

The social vulnerability literature (e.g., Cutter et al., 2003) has focused largely on disaster preparation and evacuation, and factors associated with vulnerability during evacuation may or may not coincide with factors associated with vulnerability in the post-disaster recovery and construction phases. Housing recovery is obviously important in the latter phases, and the interactions of housing conditions and options for alternate housing with pre-disaster household structure are likely to be crucial for post-disaster well-being. Here, a family and household perspective throws a very different light on social vulnerability to natural disasters than does an individual perspective. Whereas elders, for example, are most commonly identified as vulnerable demographic groups for evacuation, Myers and colleagues' (2008) application of the social vulnerability model to post-Katrina parishes a year out found no relationship between a parish's proportion of elders and its proportion of displaced persons. Our results indicate that elders' vulnerability during the reconstruction and recovery phases needs to be understood within the context of their pre-disaster household structures. Household intactness is not an issue for a single-elder household, and this and possibly their greater rates of home ownership may have been more important than their ages alone.

Moreover, the present study's finding that adult children of the household head were especially likely to be involved in break-up of the pre-Katrina household indicates a need to examine the adverse effects of population-displacing disasters on protective household

structures at all ages. Whereas elders' needs for extended-family assistance have traditionally been emphasized (Angel et al., 2007), economic vulnerability has been shown to be higher in some cases for the adult children than for their middle-aged and older parents (Choi, 2003). In the relationships of individuals within New Orleans households explored in the present study, adult children were found to be by far the largest single group to separate from the household head following Hurricane Katrina. Further investigation into outcomes of household structure change for both adult children and their parents is needed. In some cases, these adult children will have played crucial roles caring for and economically sustaining household-heading parents. In others, adult children may have been more economically dependent on their coresident parent or parents. A greater dependence of female adult children is especially likely to be the case when the adult child has children (Hofferth, 1994). Household break-up may have severe consequences, including homelessness, for both single-parent families and single adults (Wasson & Hill, 1998; Wright et al., 1998).

An alternative, more benign interpretation of the excess household break-up that occurred following Hurricane Katrina is that the hurricane and its aftermath induced an acceleration of normal processes of household change, especially of adult children leaving their parents' homes as economically independent adults. Only with further study of post-Katrina circumstances of those who split off, and of those who remained behind or who resettled elsewhere, can the merit of this alternative interpretation be rigorously evaluated. Nevertheless, there are several arguments against such a benign interpretation. First, New Orleans children of household heads who were at the normative home-leaving ages of 19 to 21 years old at the survey date accounted for 15% of all splits, with children ages 22 to 29 accounting for a further 15% (results not shown). These are substantial proportions, but not large enough to explain the overall results. Second, studies have found that adults who were displaced by Hurricanes Katrina were much more likely to be unemployed than were those who were able to remain in or return to their pre-Katrina homes within the year (Vigdor, 2007; Zissimopoulos & Karoly, 2010), making less plausible an interpretation that transition to economic independence was associated with leaving the family home in New Orleans. Third, a benign interpretation suggests that inertia was keeping many New Orleanians' extended-family households together. Analogous arguments for why so many individuals and households did not evacuate the city in advance of the hurricane have been made and addressed persuasively (Brezina, 2008; Fussell, 2006) with counterarguments based on the lack of both economic and social resources (e.g., kin outside New Orleans) facing especially African Americans and people with lower socioeconomic status in pre-Katrina New Orleans. Thus I argue that the present study's estimates of excess household break-up fit best with the interpretation that Hurricane Katrina was not merely a disaster but a catastrophe (Quarantelli, 2006), with the large-scale break-up of family households being a major, and heretofore unquantified social dimension of this catastrophe.

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Table 1Non-Household Head Adult's^a Relationship to Household Head Before Hurricane Katrina (Percentages^b)

	New Orleans		United States	
	2005	2005	2005	2004
	DNORPS ^c	ACS ^d	ACS ^d	SIPP ^e
Spouse	42.9	41.8	55.1	59.0
Unmarried partner	3.8	7.8	6.0	5.3
Child	30.7	29.1	20.5	21.0
Parent	4.4	3.3	2.7	2.6
Sibling	2.6	3.2	2.8	2.7
Grandchild	3.5	3.1	0.9	0.7
Housemate or boarder	1.9	4.4	4.3	3.6
Other	10.1	7.4	7.6	5.2
Total	100	100	100	100
<i>n</i>	141	894	741,859	22,774
χ^2 ^f	6.3		115.2**	296.2**

Note.

^a Adult is defined as age 18 and over.

^b All estimates are weighted.

^c DNORPS = Displaced New Orleans Residents Pilot Study, household structure in August 2005.

^d ACS = American Community Survey, metropolitan areas only for the United States. The 2005 ACS includes very few post-Katrina households, and is weighted by the Census Bureau to reproduce the June "mid-year" population of individuals and of households.

^e SIPP = Survey of Income and Program Participation 2004 Panel, Wave 1, metropolitan areas only, and either the non-household head adult or household head is present in both Wave 1 and Wave 5.

^f Test of difference in distributions of relationship to household head respectively between DNORPS and ACS–New Orleans, ACS–New Orleans, and ACS–United States, and ACS–United States and SIPP (United States).

* $p < .05$.

** $p < .01$.

Table 2
Household Members' Moves and Household Intactness (Percentages of All Households^d)

Household outcome	New Orleans ^b				United States ^c		
	All	Uninhabitable ^d versus United States	Habitable ^d versus United States	Habitable ^d versus United States	All	Metropolitan Areas	Only Gulf States ^e
Household intact							
No household members moved	32.3	16.1	63.9	76.1	75.5	76.4	
All household members moved	30.9	42.7	7.8	9.9	10.3	8.8	
Household non-intact							
All household members moved	23.0	32.3	4.7	2.0	2.1	1.9	
Some household members moved	13.9	8.9	23.5	12.1	12.1	13.0	
All households	100	100	100	100	100	100	
χ^2_f		237.9**	307.5**	7.7 [†]	43.9**		
<i>n</i>	110	62	48	26,383	19,323	1,159	

Note.

^a All households in the designated category with two or more members. All estimates are weighted.

^b Data source: Displaced New Orleans Residents Pilot Study (13 to 15 months from late August 2005).

^c Data source: Survey of Income and Program Participation, Wave 1 to Wave 5 (16 months from late 2004 to early 2006).

^d "Uninhabitable" is designated when the household respondent reports that the housing unit was destroyed or damaged so seriously as to make it uninhabitable, or when the housing unit was in a neighborhood with a flood depth of 4 or more feet. All other cases are coded as "Habitable."

^e Alabama, Louisiana, and Mississippi.

^f Rao-Scott chi-square test of difference, incorporating the Displaced New Orleans Residents Pilot Study's stratified sample design:

[†] $p < .10$.

* $p < .05$.

** $p < .01$.

Table 3

Characteristics of Adult Non-Household Heads and Their Households, New Orleans and the United States^a (Percentages of All Adult Non-Household Heads in New Orleans or in Metropolitan United States)

	Habitat ^d		New Orleans ^b		United States ^c	
	Habitat ^d	versus United States	Uninhabitable ^d	versus United States	Habitat ^d	versus United States
Residence is owned	67.9		76.6		73.8	76.3
χ^2^e		1.1		0.0	0.6	0.2
Household head African American	29.6		75.0		60.0	10.8
χ^2^e		12.3**		156.6**	14.2**	175.7**
Individual is employed	66.6		57.3		60.3	61.9
χ^2^e		0.6		0.5	1.1	0.1
Educational attainment						
not high school graduate	9.0		16.3		13.9	16.8
high school graduate	20.6		33.6		29.3	26.8
any college	70.4		50.1		56.8	56.4
χ^2^e		3.7		1.5	4.6†	0.7
Relationship to head						
spouse	43.5		42.6		42.9	59.0
child	25.6		33.3		30.7	21.0
other	30.8		24.1		26.3	20.0
χ^2^e		4.6		9.0*	1.0	12.4**
Age						
19–21	15.3		8.9		11.0	10.0
22–29	10.3		17.0		14.8	17.9
30–39	20.4		14.6		16.5	18.7
40–49	25.6		25.6		25.6	20.0
50–64	19.2		22.4		21.3	20.8
65+	9.1		11.5		10.7	12.6
χ^2^e		4.6		1.9	2.8	3.2
<i>n</i>	64		77		141	22,774

Note.

^a All estimates are weighted.

^b Source: Displaced New Orleans Residents Pilot Study (DNORPS), pre-Katrina characteristics except for age (which is at the survey date).

^c Source: Survey of Income and Program Participation (SIPP), metropolitan United States, Wave 1 characteristics (late 2004) except for age (which is at Wave 5).

^d "Uninhabitable" is designated when the household respondent reports that the housing unit was destroyed or damaged so seriously as to make it uninhabitable, or when the housing unit was in a neighborhood with a flood depth of 4 or more feet. All other cases are coded as "Habitatable."

^e Rao-Scott chi-square test of difference, adjusting for DNORPS and SIPP clustering within households and for the DNORPS stratified sample design.

[†] $p < .10$.

* $p < .05$.

** $p < .01$.

Percentage of Non-Household Head Adults Splitting from the Household Head, and Propensity-Score Estimator of "Katrina Effect" on Splitting, by Pre-Katrina Relationship to Head and Post-Katrina Habitability of Residence^a

Table 4

	Observed Percentages Splitting from Household Head ^b		Propensity Score Estimator of the "Katrina Effect" on Splitting from Household Head, ^c Percentage Due to Katrina	
	United States ^d (SIPP)	New Orleans ^e (DNORFS)	DNORFS versus SIPP ^d	Estimate
All non-household heads	12.9	33.1 **	< .001	18.1 **
CI	[12.4, 13.5]	[24.5, 41.7]		[10.5, 25.7]
Sample n ^h	22,046	141		
Non-household heads, residence habitable ^f	n.a.	22.8 *	0.021	9.2 [†]
CI		[12.3, 33.2]		[0.0, 16.8]
n ^h	20,902	64		
Non-household heads, residence uninhabitable ^g	n.a.	38.2 **	< .001	24.8 **
CI		[26.5, 49.9]		[13.6, 32.4]
n ^h	21,363	77		
Spouse of household head	4.2	9.3	0.115	2.6
CI	[3.8, 4.5]	[0.1, 18.5]		[0.0, 9.3]
n ^h	12,996	58		
Adult child of household head	19.6	52.8 **	< .001	33.5 **
CI	[18.3, 20.8]	[35.2, 70.5]		[18.6, 48.4]
n ^h	4,789	45		
Other relationship to household head	31.8	48.6 *	0.026	17.5 *
CI	[30.1, 33.6]	[33.0, 64.1]		[1.6, 33.4]
n ^h	4,474	38		

Note.

^a Splitting from household head is defined as not living with the household head when surveyed 1–316 months after Hurricane Katrina.

^b Estimates are weighted.

^c Uses propensity-score stratification method of matching, with normalized sample weights in the propensity-score equation. The estimate is interpreted as the additional percentage of individuals that split from the household head due to experiencing Hurricane Katrina in New Orleans.

^d Source: DNORPS = Displaced New Orleans Residents Pilot Study.

^e Non-household head adults living in U.S. metropolitan areas. Source: SIPP = Survey of Income and Program Participation.

^f Undamaged residence or damaged but still habitable, not in high flood stratum.

^g Residence destroyed or damaged and uninhabitable, or in high flood stratum.

^h *n* is the number of observations used in the many-to-one match of the propensity score estimator; observations estimated with the "common support" option. All observations from the DNORPS are used, but not all SIPP observations are used.

ⁱ All contrasts are to SIPP all non-household heads. Chi-square test of independence between surveys adjusts for clustering in families in both DNORPS and SIPP (all U.S. metropolitan areas) and for stratified sampling in the DNORPS.

CI = confidence interval. Confidence intervals about the estimates were calculated by the bootstrap method to incorporate design effects that include clustering of non-head individuals within pre-Katrina households.

[†] $p < .10$.

* $p < .05$.

** $p < .01$.

n.a. = not applicable; all SIPP individuals matching to DNORPS individuals included in the comparison group.