Race, Social Capital, and the Health Impacts of Katrina: Evidence from the Louisiana and Mississippi Gulf Coast.

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Abstract

The primary objective of this study was to evaluate the physical health impacts of Hurricane Katrina among survivors in the severely impacted contiguous states of Louisiana and Mississippi. It has been recognized that major disasters have adverse effects on the physical and mental health of survivors both initially and over time. Using a comprehensive survey of Katrina survivors in affected Gulf Coast parishes (counties) of Louisiana and Mississippi, the pre-Katrina and Post-Katrina morbidity prevalence as reported by respondents are examined. Also assessed are the demographic and social factors predicting the likelihood of adverse health consequences of exposure to Hurricane Katrina. In a series of multivariate binary logistic regression models, gender (female), older age, and lack of social capital significantly predict the odds of Katrina-related health problems. Race (African American) is only slightly significant in predicting the odds of Katrina morbidity in one out of the three logistic regression models estimated; however, significant racial differences persist in specific Katrina-induced health symptoms with African Americans displaying higher incidence of health dysfunctions. The theoretical and policy implications of these findings are discussed.

Keywords: *Catastrophes, corrosive and altruistic communities, Disasters, Hurricane Katrina, physical health impacts, social capital, Gulf Coast.*

Introduction

Disasters are extreme events which are suddenly or gradually imposed on human populations at a particular time and geographical location. They severely disrupt the normal routines of everyday life and often exceed the capacity of the affected community or society to cope without outside help (UNISDR, 2009; Kreps, 1984, 1985; Lindell & Pratter, 2003; Forthergill & Peek, 2004; Norris, et al., 2002; Quarantelli, 2005).[2] Such events or circumstances encompass a wide range of natural, technological, natural-technological (natech), and social (e.g., civil unrest, terrorism, war, etc.) hazards or circumstances adversely affecting a specific population (Kreps 1985:50; Kreps & Drabek, 1996; Picou, 2009).

Whether from a natural or technological origin, or from a complex of related etiologies, disasters release destructive forces that engender multiple impacts that systematically permeate various levels of society (i.e., individuals, groups, communities, institutions, etc.). Lives are disrupted or terminated, the structure and functioning of existing social systems are destabilized, properties and public infrastructure are damaged, services are halted, and social disorganization, the breakdown of patterned behavior ensues. Additional impacts include physical injury, disease, and negative outcomes for human mental, physical, and social well-being. Gulf Coast communities experienced all of these adverse outcomes in the wake of Hurricane Katrina in 2005, which culminated in Katrina being a major catastrophic event (Qaurantelli, 2006; Adeola, 2009; Erikson, 2010). In many communities, life has not yet returned to normal five years after the storm. As suggested by Kai Erikson, "the storm is not yet over" (Erikson, 2010:xviii); it is still seriously impacting the region devastated by Katrina's fury.

Solnit (2009) contends that Katrina represents a succession of disasters. She notes the somewhat natural etiology of the storm, the subsequent unnatural disaster of levee breaches that flooded St. Bernard Parish and much of New Orleans, the social devastation of the failure of successive levels of government to supply evacuation and relief, the failure of the Road Home program in Louisiana, and the appalling calamity of the manner in which the local, state, and federal authorities decided to regard victims as "common criminals" with a militarized rather than a humanitarian response (Solnit, 2009:234-5). On the other hand, Quarantelli (2006) has suggested that Katrina should be characterized as a catastrophe

rather than a succession of disasters, especially given its magnitude, geographical spread, and severe impacts on multiple communities. Many survivors experienced multiple shocks, trauma, and health problems in the course of evacuation, sheltering, relocation, and eventual returning to their pre-Katrina residences in Louisiana and Mississippi.

According to Oliver-Smith (1996), disasters basically signal the failure of a society's built environment to successfully adapt to the specific features of its natural environment in a sustainable fashion. Undoubtedly, Hurricane Katrina was a significant public health catastrophe that destroyed healthcare infrastructure and exposed thousands of people to various hazards, including toxic chemical compounds, oil and petroleum, poisonous gases, bacteria, molds, and other harmful biological agents leading to acute and/or chronic morbidity (Frickel, 2005; Picou, 2009). By nature, disasters engender multiple stressors which affect people's physical and psychological well-being (Norris et al., 2002). By all accounts, Katrina represents the major catastrophe of the 21st century for the United States. The storm claimed 1,833 lives across multiple states, caused extensive destruction of property, and exposed millions of people along the Gulf Coast to multiple stressors affecting their physical and mental health (CDC, 2006; Schlenger, et al., 2006). More than one million people from the Gulf Coast were displaced and involuntarily dispersed across the United States and beyond (see Brodie et al, 2006 for the plight of evacuees in Houston, Texas). The physical and mental health effects of Katrina among Gulf Coast residents will persist as a major public health issue well into the future.

The primary objective of this research is to assess physical health issues among the survivors of Hurricane Katrina along the Gulf Coast counties/parishes of Mississippi and Louisiana.[3] This study will also address the following research questions: (1) What are the specific health conditions of survivors perceived to be directly related to Hurricane Katrina three years after the storm? (2) Are there significant differences in health status of the survivors before and after the hurricane? (3) What are the socio-demographic factors explaining the likelihood of Katrina-induced health problems? and (4) To what extent is Katrina-induced illness determined by race? In addition to these research questions, we also focus on the role of social capital for buffering physical health outcomes. That is, an empirical analysis of the relationship between social capital and health dysfunctions will be performed to test this specific hypothesis. Following the introduction, we provide pertinent background information and a literature review and subsequently, an analysis and results which culminate with a discussion of our findings and some concluding observations.

Background and literature review

On August 29, Katrina slammed into the Gulf Coast, making landfalls East of New Orleans, first near Buras in Plaquemines parish as a category 4, and subsequently along the Louisiana and Mississippi border as a category 3 with sustained winds of 125 mph (200 km/h) (see Jonkman, et al., 2009).[4] The gigantic size of the hurricane created an unprecedented storm-surge in the range of 20-32 ft. for coastal Louisiana, Mississippi, and Alabama. Damage was reported as far East as the Florida panhandle (CDC, 2006). In fact, ninety thousand square miles of the Gulf Coast were declared a federal disaster area. Hurricane Katrina was the most costly disaster, as well as one of the deadliest disasters in U.S. history with estimated damages exceeding $125 billion (Blake, et al., 2007). Additionally, loss of business revenues from various industries such as oil and gas, shipping, exports, transportation, etc., due to the destruction of infrastructure, was estimated at $150 billion (Petterson, et al., 2006). Katrina's economic devastation was catastrophic.

As has been covered extensively in the media and research literature, Katrina devastated an area of approximately 55,600 square miles along the Gulf Coast with categories 1 to 5 hurricane force winds and gusts battering several hundreds of miles of coastal areas with an unprecedented storm surge (Knabb, et al., 2009). Levees/dykes and floodwalls were breached in Orleans and surrounding parishes by this tremendous movement of water across vulnerable communities (Freudenburg, et al., 2009). Consequently, more than 80 percent of the city of New Orleans was inundated with brackish contaminated floodwater consisting of a mixture of assorted toxic chemicals, crude oil, petroleum products, heavy metals such as lead and arsenic, dead bodies of humans and animals and raw sewage, which all posed acute and long-term health concerns (Frickel, 2005; Pine, 2006; Santella, et al., 2010). Other Katrina-devastated communities in Louisiana included Chalmette in St. Bernard parish, Slidell in St. Tammany parish, several small towns obliterated in Plaquemines parish and the cities of Biloxi, Gulfport, Pass Christian, and Waveland, Mississippi. With 1,833 deaths and numerous morbidity conditions, the extensive destruction of properties reveal that Katrina was the deadliest and most costly hurricane in the U.S. in the last 50 years. As for most hurricanes, the Center for Disease Control (CDC) reported that the majority of deaths during and after Katrina were due to storm surges along the Mississippi and Louisiana coastlines and the massive flooding in the New Orleans metropolitan area (CDC, 2006).

The U.S. Congressional Research Service (CRS) estimated in November, 2005, that at least 711,698 people were acutely impacted by Katrina either because they lived in com-

munities severely flooded or that their homes suffered substantial structural damage (see Gabe, et al., 2005; Crowley, 2006). The overwhelming majority (90.6 percent) of the severely and acutely affected population lived in Louisiana, with 9.3 percent in Mississippi and 0.1 percent in Alabama. The results of an assessment of health-related needs conducted seven weeks after Katrina made landfall showed that 20.2 percent of housing units lacked clean water, 24.5 percent had no electricity, 43.2 percent lacked telephone service, and 55.7 percent of households contained one or more members with a chronic health condition. Furthermore, about half (49.8 percent) of adult residents exhibited high level of emotional distress (Gabe et al., 2005).

As pointed out by Pine (2006) and others, the Gulf Coast areas of Louisiana, Mississippi and Alabama have the highest concentration of the oil, gas, and chemical industries in the U.S. (see Chow & Elkind, 2005; Picou & Marshall, 2007; Picou, 2009; Fox, et al., 2009; Santella et al., 2010). Major oil refineries, oil terminals, offshore platforms, oil and gas wells, and various networks of pipelines are also located in this region. Louisiana's petrochemical industry accounts for 25 percent of the nation's chemicals, plastics, and fertilizers (Pine, 2006; Cruz & Krausmann, 2009). High density chemical and oil and gas industries cluster the banks of Mississippi River establishing the industrial petrochemical corridor of Louisiana (see Chow & Elkind, 2005; Santella et al., 2010; Fox et al., 2009). Furthermore, the Katrina impacted region also hosts numerous hazardous waste sites — including 31 hazardous waste sites and about 466 industrial facilities that handle large volumes of hazardous materials. Some of the waste sites are on the National Priority List (NPL) which implies they are extremely dangerous to human health and the environment.

Specifically, two Superfund sites in Orleans parish — the Thompson Hayward chemical facility and the Agriculture Street Landfill (ASL) [also known as "Dante's Inferno"] covering 95 acres of land in the lower 9th Ward of Orleans parish, posed substantial health risks. As indicated in the literature, ASL and other NPL sites in Orleans parish are hot spots of contamination for toxic chemicals such as lead, arsenic, dioxin and furans and other persistent organic compounds which are carcinogenic and harmful to internal organs (Adeola, 2000; Wilson, 2006). Residents exposed to various toxic chemicals in the New Orleans surroundings due to the "toxic gumbo" resulting from Katrina can be expected to suffer from a wide range of adverse health consequences over short and long-term time frames.

Public health studies of Hurricane Katrina have focused attention on various health problems including infectious diseases, physical injuries, insect bites and stings, respiratory problems, and health problems associated with mold exposures (CDC, 2006; Englande, Jr., 2008; Picou, 2009; Schlenger et al., 2006). Subsequently, the documented exposure of people living in temporary trailers (FEMA trailers) to formaldehyde, have also raised serious health concerns and public dissatisfaction with FEMA. Specifically, the need to track the health status of people residing in the hurricane-impacted regions has been emphasized. It is crucial to determine if survivors have any health problems due to exposure to this complex toxic environment created by Katrina.

Fox et al. (2009) conducted an empirical assessment of flood water, soil, and sediment samples at various locations in Orleans parish between September 2005 and June 30, 2006 and confirmed the presence of toxic chemicals including aldrin, arsenic, benzene, cadmium, chlordane, dieldrin, DDT, dibenzo [a, h] anthracene, lead, and benzo [a] pyrene. These researchers further posit that for these chemicals, a majority of sample results exceeded the thresholds for residential screening levels. Highest levels were found for arsenic and benzo [a] pyrene in the soil, and arsenic, benzo [a] pyrene, benzo [b] fluoranthene, and adeno [1,2,3-cd] pyrene in sediment samples. The target organs or adverse health effects of concern for the chemicals frequently found in the parish samples included kidney dysfunction, cancer, blood toxicity, liver, gastrointestinal, cardiovascular, and neurological damages, body weight problem, developmental, skin, and spleen disorder, and decreased longevity (Fox et al., 2009:836-7). The synergistic effects of these chemicals on target organs are also a cause for concern. As pointed out by Soeteman and associates, it is generally the case that disaster victims present health problems, both physical and psycho-social, in the aftermath of natural and anthropogenic disasters. Given the magnitude and vast geographical area impacted by Katrina, researchers should address health issues among the survivors of Katrina who have returned to Gulf Coast communities (Soeteman, et al., 2007).

Previous studies have addressed the multiple impacts of both natural and technological disasters with emphasis on acute and chronic impacts (Kim, et al., 2008; Noji, 2001; Mortensen, et al., 2009). The adverse health impacts of disasters may range from acute (immediate to 6 months) to medium-term (1 year to 2 years), to protracted, chronic effects spanning over two years (Picou, et al., 2004; Kim et al., 2008; Carr, et al., 1997; Edmondson & Mills, 2008). In some cases, a disaster will exacerbate pre-existing health conditions either by destroying the healthcare delivery system or by preventing accessibility of victims to healthcare providers. Researchers have investigated the acute stress disorder (ASD), post-traumatic stress disorders (PTSDs), suicidal episodes, and other emotional and psychosocial pathologies among surviving victims of disasters (Adeola, 2009a, 2009b; Kessler, et al., 2006; Weisler, et al., 2006; Picou & Hudson,

2010). Emotional or psychosocial distress has also been directly linked with physical health problems (Smith & Freedy, 2000; Schultz et al., 2005; Bourque et al., 2006). Both clinical and epidemiological studies have revealed that disaster victims suffering from chronic PTSD are more likely to experience cardiovascular and autoimmune diseases such as rheumatoid arthritis, psoriasis, diabetes, and thyroid disorder (Boscarino, 2004).

Social scientists have also assessed the demographic, physical, socioeconomic, political, and psychosocial effects of disasters on impacted populations (Lindell & Pratter, 2003; Smith & McCarty, 1996). The physical impacts often include the number of casualties (i.e., deaths and injuries), property loss, damage to infrastructure, and disruptions of essential services. As indicated by Shultz, et al. (2005:21), public health outcomes directly linked with hurricanes encompass storm-related mortality and morbidity (including injuries), infectious diseases, insect bites, psychological effects, displacement and homelessness, damage to the healthcare infrastructure, disruption of public health services, social dislocation, (destruction of existing social capital), and loss of jobs and livelihood.

Studies have also examined patterns of storm-related health problems including injuries, respiratory problems, gastrointestinal disorders, and dermal problems (Wilson, 2006; Noji, 2001; Noji & Toole, 1997). Most of these consequences disproportionately affect the most vulnerable groups such as racial/ethnic minorities, women, elderly, people with disabilities, and children. While considerable research has focused on the physical, economic, and socio-psychological *sequelae* of disasters, adequate attention is yet to be focused on the physical health impacts for disaster survivors. In most cases, assessment of the physical health impacts is often tangential or secondary to the socioeconomic and psychosocial assessments. A number of studies have made recent contributions along this line of inquiry including Schultz et al. (2005), Bourque, et al. (2006), Kutner, (2007), Englande, Jr. (2008), Uscher-Pines (2009), and Fox, et al. (2009). Among the key findings of this line of research is the direct correlation between psychological distress and physical health problems among the victims of natural and technological disasters. As Bourque et al. (2006:140) state, accounts of physical injuries and disease episodes caused by disasters are often sketchy and less accurate than reports of deaths. This problem is further compounded by the wide geographical spread of Katrina evacuees and the slow return of most survivors to their pre-Katrina residences.

As noted by Kim et al. (2008:2336), the prevalence of post-disaster health problems tends to vary over time. For instance, while the initial physical and psychological shocks may gradually dissipate in positive environments, negative social and environmental factors generally tend to prolong physical and emotional distress, social discord, and the emergence of what social scientists refer to as a "corrosive community" (Freudenburg, 1997). The term "corrosive community" has been used to describe the tendency for certain disasters, such as technological or natural-technological disasters, to damage individuals, communities, and social bonds over a protracted period (Freudenburg, 1997; Picou, et al., 2004). Three critical factors — including the mental and physical health of disaster survivors, "recreancy" [or governmental or organizational ineptitude], and prolonged litigation, have been identified as explanations of why a corrosive community often emerges and persists after an unnatural disaster (Gill & Picou, 1998; Arata, et al., 2000; Freudenburg, 1993, 1997; Freudenburg & Jones, 1991; Picou et al., 2004). All of these factors are present to a certain extent in all the Gulf Coast counties/parishes included in this study. Persistent post-disaster emotional distress has been reported among survivors living in unsafe or unstable communities with poor housing, social isolation, and high crime rates (Bowling, et al., 2006; Cummins, et al., 2005; Kim et al., 2008). Analyzing empirical data from the Exxon Valdez oil spill (EVOS) in Prince William Sound, Alaska, Picou, et al. (2004) found litigation stress and the status of the litigant to be strongly associated with perceived community destruction and psychosocial dysfunctions. The post-disaster social context may inhibit both mental and physical health recovery for survivors.

Ostensibly, there are several potential corrosive social contexts in the New Orleans Metropolitan Area, including high crime rates, derelict partially gutted structures, abandoned houses, and the absence of social capital in numerous neighborhoods. Ample evidence suggests that vulnerable groups such as racial/ethnic minorities and the poor suffer disproportionate acute and long-term adverse health, psychological, and social impacts from disasters (Fothergill & Peek, 2004; Colten, 2006; Adams & Boscarino, 2005; Fothergill, et al., 1999). Consequently, a significant racial gap in self-reported physical health symptoms could be expected between Black and White residents of Katrina-impacted areas of the Gulf Coast of Louisiana and Mississippi.[5]

The health dividends of social capital

Social capital has been recognized as a critical factor for disaster response and coping, especially with regards to the physical, health, and emotional impacts (see Beaudoin, 2007; Ritchie & Gill, 2007). This concept is often viewed as resources embedded in formal and informal networks and relationships that can be tapped into or mobilized in emergency situations (Coleman, 1990). As indicated by Dynes (2006:2), social capital represents the most vital resource in responding to the impacts of natural, technological, and social (i.e., ter-

rorism) hazards and disasters. This factor is considered essential because of its linkage to positive health outcomes (see Kawachi, et al., 1999). Strong and cohesive communities are characterized by high levels of social capital, while fragmented, or "corrosive" communities, characterized by weak networks, fractured social bonds, and high crime rate are known to have low levels of social capital (see Western, et al., 2005; Ritchie & Gill, 2007). It has also been suggested that high levels of social capital are directly linked with high levels of trust, unity and cohesiveness, and reciprocity in informal networks, such as family and friendship networks and in formal networks such as the entire community, local groups, formal organizations, associations, and institutions (Western et al., 2005:1098; Barnshaw & Trainor, 2007). Social capital can yield significant health dividends for disaster survivors.

Different forms of social capital delineated by James Coleman include: obligations and expectations (with the elements of trust and extent of obligations held), information potential, norms and effective sanctions, authority relations, participation in appropriate social organizations, and intentional organizations (Coleman, 1990:304-313). While our measures are unable to cover the entire domain of social capital, they are sufficient as proxy indicators to reflect some of the key components of this concept. For instance, the extent of involvement in organizations and groups in community, people helping other people, the extent of arguments within the family, the expression of feelings of powerlessness in making important decisions are all considered important dimensions of social capital. Therefore, it is expected that respondents' Katrina-related health outcomes would be a function of social capital, holding all other factors constant. This hypothesis can be formally stated as follows: *survivors with high levels of social capital will display positive health outcomes and those with low levels of social capital will be more likely to exhibit negative health outcomes*. In other words, Katrina survivors with high levels of social capital will enjoy positive health dividends, while those without social capital will suffer diminutive health outcomes. This hypothesis and the research questions noted above will be addressed through a series of statistical analyses presented below.

Data and analytical methods

The data employed in this study came from a random digit (RDD) telephone survey of Hancock and Harrison counties in the state of Mississippi and the five parishes (counties) of Jefferson, Orleans, Plaquemines, St. Bernard, and St. Tammany in the state of Louisiana. Taken together, these counties/parishes identify "ground zero" for Hurricane Katrina. From April 16 through May 28, 2008, the University of South Alabama polling group (USAPG) interviewed a total of 2,548 adult respondents (aged 18 years and above) in the two states, with completed interviews of 810 from Mississippi and 1,738 from Louisiana. The sampling frame consisted of approximately 30,000 RDD landline telephone numbers supplemented with 10,000 cell phone or wireless numbers in Mississippi and 15,000 RDD numbers (including 10,000 landlines and 5,000 cell phone numbers) in Louisiana.[6] To guarantee random selection of subjects, the interviewers asked for an adult with the most recent birthday to participate in the survey. This data-set represents a most comprehensive, systematic collection of empirical information on post-Katrina recovery efforts, physical and mental health issues, and psychosocial problems among the returning residents of "ground zero." The first large-scale study launched after Katrina was the Hurricane Katrina Community Advisory Group (2006)'s panel survey of 1,043 adults from Alabama, Mississippi, and Louisiana. This study has several shortcomings including extremely low response rates, especially in New Orleans, and failure to include variables and topics of interest to social scientists (see Sastry, 2008). Other studies, such as Louisiana Health and Population Survey, which collected a cross-sectional data for parishes in Louisiana directly hit by Katrina, and the 2006 Kaiser Post-Katrina Baseline Survey that interviewed 1,504 random sample of adults residing in the New Orleans metropolitan area, have limitations when compared to the current data-set (see Kaiser Family Foundation, 2007; LPHI, 2006).The former was limited to Louisiana parishes only while the latter was focused on New Orleans metro area.

A questionnaire with 123 items designed with a variety of measures to obtain desired information from the respondents in an efficient manner was used. This instrument was reviewed, pre-tested, and refined prior to administration. Consistent with RDD convention, each interview took an average of 17.25 minutes to complete and the overall completion or participation rates of 44% and 24% were achieved in Mississippi and Louisiana respectively.[7] One can speculate that the participation rate was significantly lower in Louisiana mainly because of the relative slow recovery in the area. Descriptive and multivariate analytical techniques are employed to address our research questions and to meet study objectives. First, the distribution of the sample by social and demographic characteristics and self-reported morbidity conditions associated with Katrina among the respondents will be examined for residents in each state.

Table 1 displays the socio-demographic characteristics of the sample. The breakdown by state, Parishes/counties, and other socio-demographic factors are presented. The RDD telephone survey was more concentrated in Jefferson (26.1 percent), Orleans (25.3 percent), and St. Tammany (11.0 percent) parishes of Louisiana as well as Harrison County (25.4 percent) in Mississippi. Other counties/parish-

es marginally captured in the survey included Hancock county (6.3 percent) in Mississippi, St. Bernard and Plaquemines parishes of Louisiana with 3.7 percent and 2.1 percent respectively of the total sample.[8] The distribution by race is skewed towards white, which reflects the fact that African Americans and the poor, especially in the New Orleans Metropolitan Area (including Orleans and Jefferson parishes), were more disproportionately displaced and unable to return home at the time of the survey. Also skewed is the distribution by home ownership status. An overwhelming majority (85.2 percent) of the sample owned their homes relative to 11.7 percent renters. This also reflects the fact that the price of rental property increased more than 40 percent after the storm, making it difficult for renters to return. The majority of the respondents are married, working full-time, have no children living in their household, and between the age bracket of 46 to 64 years. The survey focused on survivors who evacuated and had returned to their area of pre-Katrina residence, survivors who never left and lived through the storm, and those who lived in "ground zero" of the storm who were dealing with the trauma of rebuilding and recovery.

Physical health symptoms such as stress, breathing difficulty, elevated blood pressure, stomach or gastro-intestinal problems, respiratory problems, and headaches have been

Table 1. Socio-demographic Characteristics of the Sample

Variable(s)	Percent (%)	n
State of residence:		
Mississippi	31.8	810
Louisiana	68.2	1738
County/Parish of residence:		
Mississippi County		
Hancock	6.3	160
Harrison	25.4	646
Louisiana Parish		
Jefferson	26.1	664
Orleans	25.3	645
Placquamines	2.1	54
St. Bernard	3.7	95
St. Tammany	11.0	280
Race:		
White	65.0	1657
African-American	20.2	514
Hispanic	1.7	44
Native American	0.8	21
Asian	0.4	9
Other	1.6	40
Refused/NA	10.3	263
Sex:		
Male	47.6	1212
Female	52.4	1336
Age Interval:		
18 - 30	5.6	142
31 - 45	18.7	476
46 - 64	40.9	1043
65 or over	21.5	547
Refused	13.3	340
Home ownership status:		
Owner	85.2	2170
Renter	11.7	297
Live with someone	1.7	44
Live in FEMA trailer	0.9	22
DK/NA	0.6	15
Level of education:		
Some High School	4.8	122
High School diploma	18.1	460
Some college, no degree	22.3	568
Assoc. degree	5.8	148
Bachelor's degree	21.3	543
Master's degree	8.7	222
Doctorate degree	2.4	61
Professional degree (law, med.)	2.3	59
NA/Refused	14.3	365
Marital status:		
Have never married	10.2	261
Married	56.7	1445
Divorced	10.7	272
Cohabitating	0.7	17
Separated	1.4	35
Widowed	7.8	199
Refused/NA	12.5	319
Employment status:		
Working full-time	45.9	1170
Working part-time	7.8	198
Unemployed	33.4	850
Refused	13.0	330
Number of children in household under 18:		
0	58.1	1481
1 - 2	22.1	563
3 - 4	4.8	124
5 - 8	0.8	21
Refused/NA	14.1	359

Total N = 2548.

commonly reported by victims of disasters (CDC, 2006; Noji, 2001). For the present study, respondents were asked if they had ever suffered from high blood pressure, irregular heartbeat, respiratory or breathing problems, headaches, nausea or stomach problems before only, after only, or both before and after Hurricane Katrina. Self-reported health measures have been used substantially in the literature, especially when access to medical records of a large number of subjects is not feasible. Self-reported symptoms of common physical health problems appear to be reliable indicators of health status (Cummins et al., 2005; Kawachi, et al., 1999).

The results obtained from our self-reported health indicators are summarized in Table 2. While the majority of respondents both in Louisiana and Mississippi reported not having any health problems, attention should be focused on the significant increase in the number of subjects reporting physical health problems post-Katrina relative to pre-Katrina. In both Louisiana and Mississippi for instance, the proportion of subjects reporting headaches increased from 1.3% and 1.0% pre-Katrina to 13.3% and 13.2 % post-Katrina respectively; for nausea or stomach problems, the percentages rose from 0.8 and 0.5 to 12.5 and 13.8 respectively. Also, irregular heartbeat and high blood pressure were more frequently reported as post-Katrina symptoms than before the storm. Reflecting the fact that poor health and poverty were perennial problems both in Louisiana and Mississippi, a sizable percentage of respondents indicated that they suffered from high blood pressure, headaches, and respiratory problems both before and after the storm. Nonetheless, we observe a consistent increase in self-reported health problems in the aftermath of Katrina across Mississippi and Louisiana.

Multivariate measures and analysis

Following the examination of sample distribution and descriptive data, a series of multivariate statistical analyses was conducted to address the research questions and meet our study objectives. Logistic regression and discriminant analyses were performed to determine the factors associated with the odds (or log of odds) of Katrina-related illnesses and similarity or differences in morbidity conditions among survivors.

Logistic regression

Logistic regression is an analytical technique which allows one to predict a discrete outcome, such as group membership, from a set of independent variables that may be continuous, categorical, discrete or a combination of these. For instance in biomedical research, a typical binary/discrete outcome of interest to a researcher is whether each patient in a group survives or dies (Warner, 2008; Tabachnick & Fidell, 2007). This technique is appropriate for this research for assessing if respondents have had any physical health problems as a result of exposure to Hurricane Katrina. For the present purpose, an item in the questionnaire which asked respondents: "Have you had any health problems that you think might have resulted from or gotten worse due to your experience with hurricane Katrina?" was used as the dependent or outcome variable. This was re-coded as 1 = yes, and 0 = otherwise. The independent variables consist of 15 items from the questionnaire including 7 socio-demographic variables encompassing home ownership status (dummy coded), race (coded white = 0, black = 1), marital status (coded married = 1, unmarried = 0), employment (coded : working = 1, not working = 0), educational attainment (measured on a scale of 1 [some high school] to 8 [professional degree]); age was measured in years, and sex (was coded as male = 0, female = 1).[9] One item also included in the analysis asked respondents how long after the storm before they returned to live in their homes (i.e., this item was measured in days, weeks, and months).[10]

Among the remaining items included in the analysis, five are considered proxy or indirect measures of social capital and two items measure respondents' concerns about environmental risks in their community. Six of these items are measured on Likert scale of 1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, and 5 = strongly agree. For social capital, the items on the questionnaire asks respondents the extent to which they agree or disagree with the statements that since Katrina: "I have been less involved in organizations and groups in my community;" "people in my neighborhood have been more likely to help each other out;" "there have been more arguments in my family;" "I

Table 2. Self-Reported Health Problems Before and After Katrina among Respondents

	Louisiana		Percent (%)			Mississippi			Percent (%)	
Health Problem	**Before**	**After**	**Both**	**NA**	**Dk/na**	**Before**	**After**	**Both**	**NA**	**Dk/na**
High Blood Pressure	4.3	7.7	27.2	49.8	10.0	5.4	7.7	24.5	51.5	11.4
Irregular heartbeat	2.3	6.6	8.4	69.7	13.0	4.9	7.4	10.0	66.8	11.5
Headaches	1.3	13.3	14.8	58.1	12.5	1.0	13.2	16.6	59.6	9.6
Nausea/stomach problem	0.8	12.5	7.6	66.6	12.5	0.5	13.8	7.9	68.8	9.9
Respiratory problems	1.6	11.2	9.8	65.3	12.0	0.7	13.5	10.6	65.8	9.3

N = 2,511. Note: NA = Not at all, Dk = Don't know, and na = no answer.

don't have the power to make important decisions." One item added to the social capital proxy measures asks respondents how long the separation from family members lasted. Intuitively, separation from family members for a considerable period of time could be considered a critical aspect of social capital diminution. For toxic chemical exposure concerns, respondents were asked the extent to which they agree or disagree to the statements that: "Myself and family members have been exposed to dangerous chemicals;" and "I worry there are dangerous chemicals in my neighborhood."

Multivariate Discriminant Analysis (MDA)

The multivariate discriminant analysis (MDA) is a statistical technique which enables researchers to examine the differences between two or more mutually exclusive groups with respect to several predictor variables simultaneously (Klecka, 1980; Tabachnick & Fidell, 2007). Basically, it involves finding optimal weighted linear combinations of scores on several predictor or discriminant variables that make the best possible predictions for scores on an outcome variable.[11] MDA employing two categories of race (Black and White) as the outcome variable and eight predictor variables concerning physical health and toxic chemical exposure concerns, was performed.[12] The six physical health measures taken from the survey ask respondents to indicate whether they have suffered from each of the health conditions presented before Katrina only, after Katrina only, or both before and after the storm as previously mentioned. The two measures of respondents' concerns about toxic chemical exposure remain as previously described.

Results

The results of both descriptive and multivariate statistical analyses clearly point to substantial increase in health problems for respondents in Louisiana and Mississippi. In the former, the percentage of respondents with irregular heartbeat tripled, and those reporting headaches, nausea/stomach disorder, and respiratory problems increased more than tenfold after the storm. Similar patterns were found in the two Gulf Coast counties of Mississippi included in our sample. The findings of the multivariate analysis suggest that the elderly, female, African Americans, and non-home owners (or the poor) are more vulnerable and were disproportionately afflicted by Katrina-induced health problems three years after the storm. These results are consistent with Sharkey's (2007) findings that African American male and elderly were disproportionately represented among Katrina deaths and morbidity during the immediate impact phase of the disaster.

The results of multivariate analyses conducted are summarized in Tables 3 and 4. In Table 3, three logistic regression models of Katrina-induced health problems on socio-demographic and social capital indicators are displayed. For each model, both the logistic regression coefficients of change in log odds (B) and change in odds (Exp ß) calculated for each predictor variables are displayed along with Wald's statistics and the R^2 for each model. It is much easier to interpret the Exp ß or e^{Bi} than the log odds parameters; therefore change in odds (or odds ratio) is emphasized in the interpretation of our results. In model 1 in the first column of Table 3, statistically significant variables predicting the odds of Katrina-induced health problems are asterisked. Out of the fifteen variables in the model, nine are statistically significant. Among these are socio-demographic predictors including age and being female with the odds of 1.019 and 1.726 respectively (significant at $p < .01$). That is, older age and being female increase the odds of experiencing Katrina-induced health problems by 0.02 and 0.73 respectively. By convention, an odds ratio greater than 1 signifies that the odds of being afflicted by Katrina-induced health problems increase when the predictor variable increases; and an odds ratio of less than 1 indicates that the odds of Katrina-induced health problems decrease when the predictor variable increases (Menard, 1995). Thus, home ownership consistently predicts the odds of decreased Katrina-related health problems in all the models ($p < .05$ in model 1 and $p < .01$ in models 2 and 3).

Much attention has been focused on the influence of race in Katrina-induced mortality, morbidity, and community destruction (Sharkey, 2007; Danziger & Danziger, 2006). One would expect race to be a crucial factor explaining Katrina-health problems with African Americans being the most likely to exhibit negative health outcomes. In the first equation (model 1) of Table 3, race is significant at $p < .10$ level indicating that being Black or African American results in a .15 increase in the odds of health problems due to Katrina exposures. However, the level of significance disappears across other models with more parsimonious predictor and control variables. Among the proxy measures of social capital, the items concerning "less involvement in organizations and groups," "feeling of not having power to make important decisions," and "more arguments in the family" since Katrina significantly predict the odds of Katrina-related health problems among the subjects. One could argue that the reciprocal of these measures are the essence of social capital — i.e., meaningful involvement in organizations and groups, empowerment in making important decisions, cooperation and unity within groups and social institutions including one's family would help attenuate stress and adverse health impacts. The results presented in Table 3 suggest that, the higher the levels of social capital possessed by survivors, the less the likelihood of Katrina-related health problems. In short, the lack of social capital is a significant predictor of post-Katrina health

problems, controlling for a wide variety of other variables known to be important for predicting disaster impacts.

Table 3 also reveals that the respondents' attitudes concerning how worried or concerned they are about dangerous chemicals dispersed in their neighborhood was a significant predictor of health dysfunctions. As expected, the more concerned people are about exposure to dangerous chemicals in their neighborhood environment, the higher the odds of Katrina-linked morbidity as indicated by odds ratios of 1.426 and 1.331 respectively ($p < .01$). The non-significant predictor or

Table 3. Logistic Regression of Katrina-Related Health Problems on Social Capital and Socio-demographic Variables

Predictor Variables	Model 1 B (Exp ß)	Model 2 S.E	Model 3 Wald's Statistic	B (Exp ß)	S.E.	Wald's Statistic	B (Exp ß)	S.E	Wald's Statistic
Home Ownership	-.486** (.615)	.221	4.833	-.533*** (.578)	.183	8.469	-.533*** (.587)	.016	8.476
How long after the storm before returning to live in your home	.049 (1 .050)	.069	.498						
Race (White = 0, Black = 1)	.142* (1.152)	.085	2.777	.102 (1.107)	.072	1.994	.102 (1.107)	.072	2.001
Marital status (married = 1, non-Married = 0)	.006 (1.006)	.176	.971						
Education attainment	-.005 (1.005)	.047	.013	-.004 (.996)	.037	.012	-.004 (.996)	.037	.012
Employment (working full/part-time = 1, not working = 0)	.106 (1.112)	.179	.354						
Since Katrina, there have been more arguments in my family	.313*** (1.367)	.067	21.486	.377*** (1.457)	.057	44.249	.377*** .057 (1.457)	44.251	
I don't feel I have the power to make important decisions since Kat	.293*** (1.341)	.076	14.783	.261*** (1.298)	.064	16.834	.261*** .064 (1.298)	16.875	
How long did separation from your family last?	.020 (1.020)	.013	2.516	.015* (1.015)	.008	3.135	.015* (1.015)	.008	3.134
I have been less involved in Organizations & groups since Kat	.139** (1.149)	.065	4.581	.121** (1.129)	.055	4.804	.121** (1.129)	.055	4.813
People in my community have been more likely to help each other	-.059 (.942)	.065	.825	.002 (1.002)	.055	.001			
Myself & family members have been exposed to dangerous chemicals	.355*** (1.426)	.059	36.521	.364*** (1.439)	.050	53.060	.364*** (1.439)	.050	53.304
I worry there are dangerous chemicals in my neighborhood	.286*** (1.331)	.066	18.550	.290*** (1.337)	.058	25.111	.290*** (1.337)	.058	25.121
Sex (male = 0, female =1)	.546*** (1.726)	.167	10.632	.527*** (1.693)	.135	15.194	.527*** (1.693)	.153	15.194
Age	.018*** (1.019)	.005	15.688	.014*** (1.014)	.004	14.171	.014*** (1.014)	.004	14.181
Constant	-4.980*** (.007)	.586	72.151	-4.799*** (.008)	.438	120.009	-4.792*** (.008)	.390	151.249
Cox & Snell's R^2	.298			.279			.279		
Nagelkerke's R^2	.401			.381			.381		
n	935			1403			1403		

***p < .001, **p < .05, *p < .10 statistical significance respectively.

control variables were removed in models 2 and 3 of Table 3 to achieve parsimony. Duration of separation from family becomes modestly significant in models 2 and 3 predicting the odds of health problems ($p < .10$). The percentage of variance explained for each model as determined by Nagelkerke R^2 is 40% for model 1 and 38% for models 2 and 3, revealing rather robust results. In the analysis, the socio-demographic determinants of the odds of Katrina-induced health problems have been assessed with age, female sex, and, to some extent, race found as significant determinants of the odds of adverse health outcomes of Katrina exposure. As expected, home ownership represents a significant socio-demographic variable which attenuates the odds of Katrina-related health problems.

The specific health conditions identified by respondents as being directly attributed to Katrina have been discussed and our analyses of respondents' health status before and after Katrina reveal the storm exacerbated health problems among survivors. The socio-demographic predictors of Katrina-induced health problems (age, sex, home ownership, and race) were statistically significant in the logistic and discriminant models. The final research question concerning the extent to which Katrina morbidity is determined by race revealed partial, or inconclusive, support in the logistic regression models.

Because the effect of the variable "race" in the logistic regression models was inconclusive, an alternative analytical technique was employed to examine differences in Katrina-related health symptoms. The MDA was calculated and the results are summarized in Table 4. For the MDA, standardized discriminant function coefficients (SDFCs), pooled within group correlations (PWGCs) in parenthesis, Wilk's lambda, F-ratios, and mean difference for each health symptom employed as discriminant or predictor variable are displayed in the table. Also shown are summary statistics for the model including group centroids, canonical correlation, eigenvalue, Wilks' lambda and chi-square, all revealing substantial differentials between the two groups. The salient 'focal' question here is "to what degree are black and white groups similar or dissimilar in Katrina-related health symptoms?" This question is directly addressed in the MDA. The mean difference

Table 4. Discriminant Analysis of Black and White Differentials on Katrina-Induced Physical Health Problems and Concerns about Exposure to Toxic Contaminants*

Discriminant Variables	SDFCs† (PWGCs)‡	Wilks' Lambda	F-ratio	Means Diff.	Sig.
Suffered from High Blood Pressure	.127 (.351)	.997	5.574	1.46	.018**
Suffered from irregular heartbeat	-.548 (.305)	.998	4.225	1.28	.040**
Suffered respiratory problems	1.163 (.463)	.996	9.710	1.84	.002***
Suffered from headaches	-1.216 (.382)	.997	6.603	1.53	.010***
Suffered nausea/stomach problems	-.115 (.396)	.997	7.097	1.64	.008***
Overall health better or worse	.241 (.545)	.994	13.461	2.26	.000***
Worry about myself of family members exposed to toxic chem.	1.035 (.889)	.984	35.820	3.62	.000***
Worry about dangerous chemicals in my neighborhood	.053 (.814)	.987	30.040	3.49	.000***
Group Centroids:					
White	-.086				
Black	.240				
Canonnical Correlation (CCr)	.142				
CCr^2	.020				
Eigenvalue	.021				
Model's Wilks' Lambda	.980				
χ^2 (df = 8)	44.786***				

*Note: N = 2,202 (1,621 white and 581 black respondents); ***p < .001, **p < .05 significance respectively; SDFCs = Standardized Discriminant Function Coefficients, and PWGCs = Pooled Within Groups Correlations. 70.4% of original grouped cases were correctly classified.

for each item between the two groups was calculated and displayed in the second to the last column of Table 4. Clearly, significant disparities exist between Blacks and Whites on every item displayed in Table 4, including all the health symptoms before, during, and after Katrina and concerns about toxic chemicals in their neighborhoods. African Americans had poor ratings of overall health and they are more likely to be afflicted by respiratory problems, nausea or stomach problems, headaches, high blood pressure, and irregular heartbeat relative to their white counterparts. The SDFCs displayed in the first column of the table shows the strength of each predictor variable's contribution to the only one discriminant function possible for this model with two groups. The overall model's Wilks' lambda of .980, group centroids of -.086 white and .240 black, and chi-square of 44.786 suggest a statistically significant discrimination between the two groups on all predictor variables. The classification results yield 70.4% correct classification of grouped cases.

The role of social capital in explaining differential health outcomes of a disaster such as Hurricane Katrina has been demonstrated. In the logistic regression models, the lack of social capital significantly predicts the odds of Katrina-related health problems independent of race and other control variables. Given the fact that African American communities, especially in Orleans parish, were devastated and most of their social networks, organizations, and institutions were destroyed by Katrina, it should not be surprising that a gap exists in their vulnerability and susceptibility to adverse health consequences. Most health establishments catering to the healthcare needs of African Americans in New Orleans East and the Charity Hospital have not been rebuilt in more than five years post-Katrina. This fact suggests that our findings three years after Katrina may linger well into the future. These health impacts will, in all probability, continue to take a heavy toll on African American survivors.

Discussion and conclusion

In addition to meeting the objectives of this study, i.e., to assess the health issues and establish the socio-demographic predictors of health problems among the survivors of Hurricane Katrina along the Gulf Coast areas of Mississippi and Louisiana, there are theoretical and applied policy implications of our findings. Social capital theory appears to be a promising conceptual framework for understanding the structural differences in physical health and psychological resiliency of survivors of a massive catastrophe such as Katrina (Ritchie & Gill, 2007). Social bonds, norms of reciprocity, and other critical elements of social capital are capable of yielding expected health dividends for survivors in the aftermath of a disaster. Our central hypothesis, that "*survivors with high levels of social capital would exhibit positive health outcomes while those with low levels of social capital would be more vulnerable to Katrina-related health issues*," was supported. These empirical results concerning social capital loss and negative health outcomes among the survivors of Katrina also expand the theoretical utility of the social capital framework beyond research on technological disasters. The application of social capital theory to differential physical health effects of Katrina is an important contribution of the present research. Thus, our findings extend the current body of knowledge on social capital in the fields of disaster and health studies (Ritchie & Gill, 2007; Beaudoin, 2007; Kawachi et al., 1999; Durant, Jr., 2011).

The need to continuously monitor and address the physical health impacts of Katrina and associated unnatural disasters among Gulf Coast residents cannot be overemphasized. With few exceptions, a substantial gap remains in the literature addressing the physical health problems produced by Katrina, especially for long-term consequences. The present research has contributed towards filling this void, especially by revealing the spike in Katrina-related health problems three years after the storm. Today, Katrina remains as a disaster without a full recovery within the Gulf Coast region. The enduring adverse health consequences documented will continue to be a major impediment to recovery for returning survivors and residents struggling with the trauma of recovery. Many people returned to rebuild and live in devastated communities where they subsequently were exposed to multiple toxic contamination causing serious health problems, including respiratory dysfunctions due to mold exposures and the subsequent "Katrina cough." Furthermore, there are several ongoing physical health, mental health, and psychosocial problems affecting residents as they struggle to rebuild and achieve stability. Given our results, health and psychosocial issues continue to be prominent among numerous problems faced by Katrina survivors throughout the "ground zero" area of the storm.

To the best of our knowledge, this is the first empirical study examining the relationship between social capital and health outcomes among Katrina survivors. Several Katrina-induced problems, including different sources of contamination, public health risks, and stress, abound within the region and will continue to pose serious threats to the well-being of the survivors in the future. High crime rates (especially in the New Orleans metropolitan area), stresses and strains, and diminished social trust continue in several areas characterized as "corrosive communities" with diminished social capital, while altruistic communities with high levels of social capital can be found in a number of areas that have achieved substantial recovery. The fact that social capital yields substantial dividends, providing an important source of support for

survivors over time, is an important contribution for understanding variations in how health problems are experienced in Katrina's aftermath. Indeed, the vulnerability of African Americans to health problems clearly points to concerns that need to be continuously addressed by public health authorities. Continuing health problems are not only a function of low-income, lack of insurance, and inaccessible health care providers, but also a reflection of a lack of social capital at the community level.

The policy implications of our findings are unambiguous and suggest the need to allocate adequate resources for rebuilding the healthcare infrastructure in Louisiana and Mississippi Gulf Coast communities. Clearly, social capital is an important element for community recovery. It is a promising concept for understanding disaster vulnerability, coping, and resiliency. Even with our limited measurement, the proxy, or indirect indicator of social capital clearly supported the hypothesis that groups with limited social capital would fare worse than those with strong social capital for disaster-related health outcomes, holding all other factors constant. Future studies are encouraged to further explore this line of inquiry. Researchers are especially encouraged to further pursue empirical studies of demographic and racial disparities in disaster experience, impacts, social capital, and resiliency.

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End Notes

1. fadeola@uno.edu
2. Enrico Quarantelli has designated five key features of a disaster which encompass the elements found in most social scientific definitions of the concept, including: (a) sudden-on-set occasions, (b) serious disruption of the routines of groups, communities, or collective units, (c) necessitating the adoption of an unplanned or spontaneous course of action to respond and adjust to the disruption, (d) having unexpected life histories designated in space and time, and (e) posing significant danger to valued objects (see Quarantelli, 2005). Disaster has been redefined from an occasion confined in time and space to an event unfolding across time and space (Qurantelli, 2005; Tierney, 2007).
3. The term "survivors of Katrina" as used in this article refers to people from Katrina impacted counties/parishes within the Mississippi-Louisiana Gulf Coast who evacuated and later returned, those who never left (i.e. those who rode out the storm), and other post-Katrina residents directly involved in cleaning up and rebuilding and consequently dealing with the trauma of recovery at the time of the survey.
4. See National Hurricane Center's The Saffir-Simpson Hurricane Scale Summary Table at: www.nhc.noaa.gov/sshws_table.shtml (accessed 2/6/11). The scale was developed in 1969 by Herbert Saffir, a consulting engineer, and Bob Simpson, director of the National Hurricane Center, to make comparison easier and to make the predicted hazards of approaching hurricanes clearer to emergency managers, planners, National Oceanic and Atmospheric Administration's Weather Forecasters, and the public. See http://www.aoml.noaa.gov/general/lib/laescae.html (accessed 2/6/11).
5. Pre-existing social inequalities suggest there was a substantial gap between Black and White residents of Louisiana and Mississippi Gulf Coast prior to hurricane Katrina. This gap was widened by Katrina. Respondents in this survey were asked specifically to indicate their health problems caused or exacerbated by Katrina. It was not a matter of perception; rather, it was a matter of who reported specific health problems.
6. A standard RDD sample was acquired from a highly reputable vendor, ASDE Survey Sampler, Inc., for both Louisiana and Mississippi parishes/counties impacted by Katrina. As mentioned, the sample included basic land lines, supplemented by RDD cell phone numbers. Given the nature of RDD sample, the result of the current survey can be generalized to the population of the entire area of study.
7. Declining survey response rates over the past decade have been of concern to survey researchers (Groves at al., 2004). The decline in response rates is more pronounced for RDD telephone surveys than for any other types of survey (Groves, 2006; Lee, Brown, Grant, Belin, and Brick, 2009; SHADAC, 2008; Davern, et al., 2010). For health and disaster studies, RDD surveys with 20-40 percent response rates are considered acceptable. Furthermore, as noted by Lee (2009:1811) and SHADAC (2008:1), surveys with response rates under 20 percent had a level of non-response bias similar to that of surveys with response rates over 70 percent. Thus, our participation rates of 44 percent and 24 percent for Mississippi and Louisiana respectively are considered appropriate for generalization purposes.
8. Extreme caution must be exercised in any generalizations to the parishes/counties with less than 5 percent of the total sample.
9. The composition of Hispanic, Native American, Asian, and other racial groups was extremely small as shown in Table 1, therefore, these racial categories were excluded in the multivariate analysis.
10. The survey did not collect any information about personal or family income from the respondents; therefore, income is not among the socio-demographic variables used in this study. However, home ownership, employment, and educational attainment are used as important indicators of respondents' socio-economic standing.
11. A discriminant function is an optimal weighted linear combination of scores on the predictor variables. For a research condition where the outcome variable involves just two groups as in the present case, the equation for single standardized discriminant function Di used to predict group membership is: $D_1 = d_{11} z_1 + d_{12} z_2 + \ldots + d_{1p} z_p$

Where: z_1, z_2 . . . , zp are the standardized scores of the predictor variables X_1, X_2, . . ., Xp. See Warner (2008:653).

12. See note 8 above.

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