Hurricane Katrina: A Case Study of its Impacts on Medical Service Providers and Their Client Populations*

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Abstract: There is a great deal of literature in the areas of: (1) medical demography; (2) the effect of disasters on first responders; (3) measuring the immediate demographic and social effects of a disaster; and (4) the short and long term economic and financial effects of disasters. However, there is very little if anything about the demographic effects of large scale disasters on medical providers once rescue operations have been completed and operations move into the relief and recovery/rehabilitation phases associated with a disaster. This paper seeks to bridge this gap by providing as a "recovery/rehabilitation" case study, estimates of the effects of Hurricane Katrina on the client populations and candidates for a specific medical procedure in the service areas associated with two medical facilities on the Mississippi gulf coast. The estimates presented here show that Katrina had a substantial demographic impact and that this translated into an adverse impact on the client base of both medical facilities. Although the results come from a single case study, the results suggest that the effects of a disaster can have substantial impacts on medical care providers and their ability to continue business that goes well beyond physical damage. That is, these results suggest that the impact of demographic effects of a disaster on a client base can be more important than physical damage, a fact that does not appears to be widely recognized. The first step in effectively dealing with a disaster is the presence of a plan and it is typical of organizations to have both "disaster recovery" plans and "business continuation" plans. Given the long term effects of Katrina on client populations found in this case study, it would be prudent that medical care providers include estimates of demographic impacts on their client populations in these plans, particularly in regard to the long-term "effects horizon" of a given disaster

INTRODUCTION

There is a great literature in the areas of: (1) medical demography [1-12]; (2) the effects of disasters on first responders [13] ; (3) Measuring the immediate demographic and social effects of a disaster [14-18]; and (4) the short- and long-term economic and financial effects of disasters [19]. However, there is virtually nothing in the literature about the demographic effects of large scale disasters on medical providers once the rescue attempts have ended and operations move into the relief and recovery/rehabilitation phases associated with a disaster. There are several reasons why this knowledge gap needs to be filled in: First, medical providers themselves should be prepared to deal with the adverse affects of a disaster not only on their physical structures and staff, but also on the client populations they serve; second, recovery agencies need to understand that the loss of client populations represents a major problem to medical care providers that has not been adequately addressed; and third, accountants, litigators, financial planners, and actuaries need to be cognizant of these effects in advance of major disasters, which suggests that more research needs to be done in this area by medical sociologists and demographers.

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This paper seeks to start to bridge this gap by providing as a case study, estimates of the effects of Hurricane Katrina on "recovery/rehabilitation phase" populations and medical procedure candidates in the service areas (defined by zip codes) associated with two medical facilities in the area of Biloxi, Mississippi, USA.

While this paper is only a single case study, it provides an illustration of the impact that a major disaster can have on the client base of a medical provider. The estimates presented here show that Katrina had a substantial demographic impact, which in turn impacted the client base underlying both medical facilities. As such, the results suggest that the effects of a disaster can have substantial impacts on medical care providers and their ability to continue business.

It is worthwhile to use Hurricane Katrina as a case study for at least three reasons. First, while relatively recent, sufficient time as gone by since it struck the Mississippi Gulf Coast on August 29th, 2005 for affected areas to have moved into the recovery phase. Second, data were collected after Katrina's impact that used US Census Bureau procedures and definitions, which allow for estimates to be generated that are consistent with census and related data. One effect of this is that population data can be generated that reflect the impact of Katrina and what would have been expected in the absence of Katrina. Third, as noted by Swanson *et al.* [18], the landfall of Hurricane Katrina on the Gulf Coast represented the greatest natural disaster in American history: at least 1,836 people lost their lives from Katrina; hundreds of

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Table 1. The Estimated 2007 Population of Service Area 1 by Age and Sex

SERVICE AREA 1 2007 POPULATION BY AGE & SEX				
	2007	2007	2007	2007
SEX & AGE GROUP	Zipcode 1	Zipcode 2	Zipcode 3	TOTAL
v 2_4	798	1,363	441	3,621
v 4_9	663	1,344	474	3,483
v 12_14	674	1,314	641	3,632
v 14_19	971	1,343	497	3,731
v 32_34	1,117	1,136	393	3,636
v 34_39	816	1,383	427	3,424
v 32_34	773	1,423	416	3,793
v 34_39	679	1,384	433	3,496
v 42_44	471	1,381	446	3,499
v 44_49	688	1,399	427	3,494
v 42_44	644	1,332	466	3,339
v 44_49	467	934	346	1,837
v 62_64	412	764	383	1,448
v 64_69	339	461	198	1,288
v 72_74	338	383	119	742
v 74_79	178	348	123	439
v 82_84	123	118	42	362
v 84ovr	83	41	33	147
_2_4	1,249	1,343	441	3,743
_4_9	1,269	1,363	446	3,788
_12_14	998	1,334	414	3,747
_14_19	992	1,343	478	3,713
_32_34	1,234	1,214	424	3,443
_34_39	1,247	1,369	443	3,868
_32_34	1,244	1,383	446	3,893
_34_39	922	1,339	497	3,734
_42_44	726	1,333	419	3,449
_44_49	618	1,313	434	3,346
_42_44	448	1,337	436	3,322
_44_49	447	1,223	338	1,887
_62_64	468	864	343	1,674
_64_69	634	616	144	1,394
_72_74	494	449	137	1,282
_74_79	422	321	71	773
_82_84	324	193	41	437
_84ovr	344	134	37	397
P2_4	1,847	3,624	893	4,343
P4_9	1,731	3,627	931	4,369
P12_14	1,673	3,442	1,144	4,377
P14_19	1,961	3,496	976	4,433
P32_34	3,141	3,141	797	4,289
P34_39	1,873	3,641	849	4,373
P32_34	1,837	3,884	973	4,684
P34_39	1,479	3,733	1,239	4,331
P42_44	1,377	3,724	1,266	4,247
P44_49	1,326	3,713	933	4,941
P42_44	1,193	3,446	891	4,432
P44_49	1,114	1,936	684	3,734
P62_64	1,278	1,638	434	3,333
P64_69	943	1,177	343	3,483
P72_74	733	843	346	1,832
P74_79	478	449	173	1,322
P82_84	426	312	83	797
P84ovr	337	176	42	444
AOAA9	33,616	34,138	13,624	71,348
POP 44+	4,189	6,628	3,113	13,911
POP 64+	3,996	3,244	924	6,944

thousands of Gulf Coast residents lost their homes and jobs; and economic losses have been estimated at $81.2 billion in (2005 dollars), nearly double the costs associated with the next most costly disaster, Hurricane Andrew ($45 billion in 2005 dollars) and nine times more than Hurricane Camille ($9 billion in 2005 dollars).

The case study is presented in two parts. The first examines the demographic effects of Hurricane Katrina on two service areas associated with a medical provider and the second part consists of an examination on the effects of Hurricane Katrina on the candidates for a specific medical procedure from these two service areas. The report concludes with a discussion of the effects on both population and the candidates as an illustration of the broader effects that a major disaster can have on the ability of medical service providers to continue business. The appendix documents the data and methods used in the study.

Before proceeding on to the results, it is worthwhile to note here what is meant by the post-disaster phases of rescue, relief, and recovery/rehabilitation. The definitions provided by the Asian Disaster Reduction Center [20] are used for this purpose.

The rescue phase usually consists of a forty-eight period immediately following a disaster in which local people and trained professionals attempt to save lives among the affected population. When rescue operations end, the relief phase begins in which food, water, clothing, medical supplies, shelters, and other elements associated with basic survival are delivered to the affected population. This phase usually lasts between one to three months. In the recovery/rehabilitation phase, social, economic and other infrastructures are restored and the economy revitalized. In the short term, debris clearing and removal usually takes place, while in the longer term, rebuilding is undertaken. This phase usually lasts for one to several years, but can be as long as five years.

DEMOGRAPHIC EFFECTS OF KATRINA

The examination of Katrina's demographic effects, proceeds by using 1990 and 2000 census data to develop "Cohort Change Ratios" [21] for the two service areas of the medical provider. These Cohort Change Ratios (CCRs) are then used to project the 2000 populations by age and sex forward to 2007. The projected population numbers are then adjusted using two sources: (1) data collected under the auspices of a study funded by the National Science Foundation [18]; and (2) special "Katrina estimates" done by the US Census Bureau [22]. These adjusted values form the 2007 "Katrina-impacted" populations (by age and sex) of the two service areas. To get an idea of the magnitude of population lost due to Katrina, these estimates are then compared to projections of the populations for these same two areas that were constructed by a well-established private sector data vendor in 2003, well in advance of Hurricane Katrina.

Table **1** provides the estimated "Katrina-impacted" population in 2007 of Service Area 1 by age and sex. Table **2** provides the estimated Katrina-impacted population in 2007 of Service Area 2 by age and sex.

In regard to the effects of Hurricane Katrina on the total population of Service Area 1 (Table **1**), the total Katrina-impacted population in 2007 is 68,465. This is 10,246 less

Table 2. The Estimated 2007 Population of Service Area 2 by Age and Sex

SERVICE AREA 2 2007 POPULATIO&BY AGE A&D SEX										
SEX & AGE GROUP	**Zipcode 4**	**Zipcode 5**	**Zipcode 6**	**Zipcode 7**	**Zipcode 8**	**Zipcode 9**	**Zipcode 10**	**Zipcode 11**	**Zipcode 12**	**TOTAL**
r 2_4	433	618	347	648	828	464	164	311	343	4,147
r 4_9	474	647	146	468	788	637	174	331	374	3,941
r 12_14	481	733	337	467	863	642	181	344	376	4,323
r 14_19	416	644	349	491	974	619	143	394	367	4,317
r 32_34	643	487	133	643	647	439	133	343	314	3,693
r 34_39	664	423	313	766	693	414	133	183	324	3,873
r 32_34	447	483	319	613	844	429	146	317	337	3,934
r 34_39	482	714	331	624	869	461	149	341	347	4,396
r 42_44	442	737	342	414	939	488	177	329	332	4,364
r 44_49	486	821	418	479	1,263	449	184	333	343	4,673
r 42_44	491	933	426	486	931	496	194	334	342	4,621
r 44_49	444	773	341	429	739	443	172	323	341	3,781
r 62_64	421	647	494	383	624	422	144	179	192	3,464
r 64_69	389	433	338	336	443	316	111	137	163	3,444
r 72_74	376	348	324	192	334	342	83	84	113	1,974
r 74_79	332	312	322	173	333	161	49	42	74	1,383
r 82_84	136	134	126	128	93	97	32	39	41	774
r 84ovr	98	84	124	84	66	48	17	8	34	433
_2_4	468	474	336	637	733	436	182	326	343	3,823
_4_9	493	493	187	432	774	484	148	183	334	3,717
_12_14	488	648	323	478	847	644	164	333	378	4,126
_14_19	481	614	332	464	793	623	169	323	377	4,233
_32_34	487	413	143	746	644	433	136	337	347	3,796
_34_39	672	466	382	694	833	491	166	174	334	4,128
_32_34	434	487	373	642	826	629	146	199	313	4,228
_34_39	498	684	326	444	944	644	163	333	374	4,421
_42_44	444	722	424	423	943	633	178	313	331	4,338
_44_49	624	847	427	443	1,232	622	193	334	384	4,743
_42_44	488	844	479	469	884	614	193	334	338	4,444
_44_49	434	736	464	418	744	492	173	318	341	4,227
_62_64	464	727	443	349	641	486	144	163	189	3,617
_64_69	366	493	387	377	494	346	132	132	164	3,769
_72_74	343	348	312	334	386	329	89	83	116	3,338
_74_79	388	363	194	338	344	333	73	63	99	1,684
_82_84	332	186	196	166	142	144	41	44	73	1,343
_84ovr	146	198	174	144	134	131	43	38	77	1,266
P2_4	1,222	1,193	493	1,374	1,442	1,291	344	417	494	7,949
P4_9	968	1,342	343	1,288	1,464	1,311	333	414	429	7,648
P12_14	969	1,382	632	946	1,732	1,384	346	478	444	8,329
P14_19	997	1,369	668	947	1,766	1,333	331	496	444	8,342
P32_34	1,342	999	376	1,429	1,323	1,243	369	482	463	7,489
P34_39	1,334	1,269	491	1,463	1,434	1,224	398	347	439	7,981
P32_34	1,283	1,169	493	1,343	1,661	1,117	323	417	442	7,933
P34_39	1,178	1,399	637	1,149	1,833	1,326	311	464	431	8,697
P42_44	1,286	1,437	744	1,217	1,883	1,332	346	431	443	8,623
P44_49	1,189	1,648	834	1,133	3,283	1,149	376	468	437	9,436
P42_44	1,178	1,788	884	944	1,826	1,312	387	449	488	9,146
P44_49	978	1,427	816	837	1,473	943	343	432	483	7,789
P62_64	866	1,364	946	743	1,347	886	312	341	379	7,281
P64_69	644	1,236	714	413	939	663	331	347	337	4,313
P72_74	638	696	614	434	732	449	173	168	339	4,323
P74_79	428	473	394	413	478	384	133	113	174	3,266
P82_84	347	331	323	374	343	343	82	74	114	3,216
P84ovr	344	383	379	337	321	169	49	36	121	1,499
AOAA9	16,448	32,372	12,643	16,272	33,972	16,632	4,949	6,347	7,338	133,494
Pop 44+	4,336	4,672	4,267	3,419	4,399	3,843	1,336	1,398	1,827	31,266
Pop 64+	3,393	3,798	3,324	1,841	3,479	3,214	674	637	946	16,196

than the 2007 population of 78,711 projected in 2003 by the well-established private sector data vendor for this same area. Thus, Katrina is estimated to have reduced the total population of this area by 13 percent as of 2007, approximately two years after it struck.

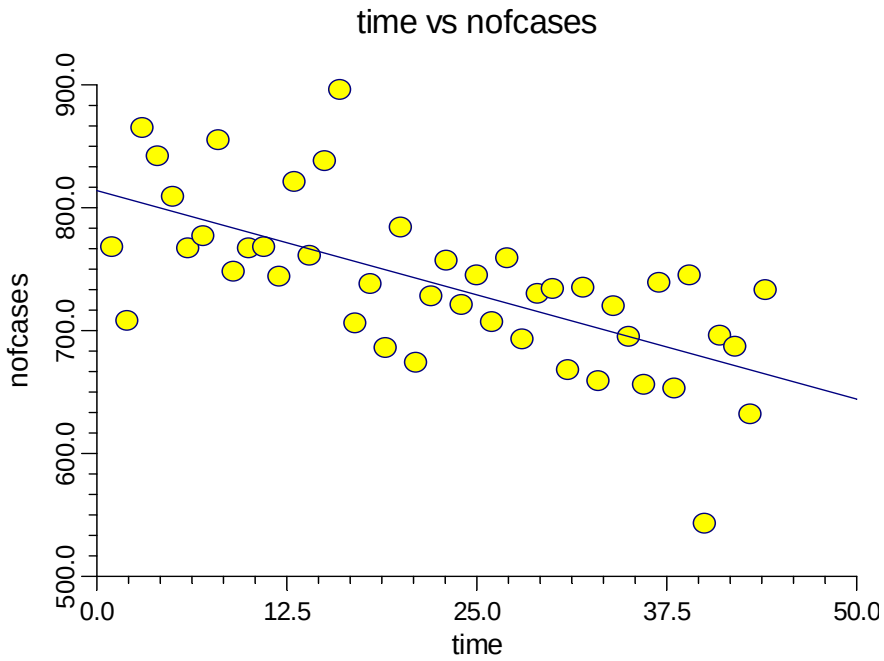

Fig. (1). The number of procedures performed at facility x related to the pool of potential medical procedure patients in the two service areas.

For purposes of the second part of this study, candidates for the specific procedure examined in this case study, it is the population aged 55 years and over that represents the client population. In looking at those aged 55 years and over, there are 13,281 people in the Katrina-impacted estimate of this age group in Service Area 1 in 2007 (Table **1**). This is 1,753 less than the 2007 55+ population of 15,034, which was projected in 2003 by the data vendor. Thus, Katrina is estimated to have reduced the population aged 55 years and over by 11.7 percent in Service Area 1 as of 2007.

For Service Area 2 (Table **2**), the total "Katrina-impacted" population in 2007 is 122,595, which is 23,922 less than the 2007 population of 146,517 projected in 2003 by the data vendor for this same area. Thus, Katrina is estimated to have reduced the total population of this area by 16.3 percent as of 2007. In considering age group 55+ for Service Area 2, there are 31,066 people in the Katrina-impacted estimate for 2007. This is 5,532 less than the 2007 projected 55+ population of 36,598 by the data vendor for Service Area 2. Thus, Katrina is estimated to have reduced the population aged 55 years and over by 15.1 percent in Service Area 2 as of 2007.

KATRINA'S EFFECTS ON A MEDICAL PROVIDER

The data in Fig. (**1**) represent a monthly time series (January, 2004 through August, 2007) of transactions of diagnostic codes (ICD 9) that are associated with the pool of patients the two service areas who presented themselves for this procedure at the medical provider's site "X.". The number of cases by month is shown on the vertical (Y) axis, while on horizontal (X) axis of the exhibit, the months are shown as 0, 1, 2, 3,…, 43, where "0" represents January, 2004, "1" represents February, 2004 and so on up to "43," which represents August, 2007. For purposes of formatting, the horizontal axis numbers go to "50." The point at which Hurricane Katrina struck is represented on the horizontal axis at number "19."

As can be seen from an examination of Fig. (**1**), there is a distinct break around the point on the horizontal axis that represents the time period in which Katrina stuck (August of 2005 is represented by where point 19 would be located, which appears between 12.5 and 25 as shown on the horizontal axis). Prior to September, 2005, Facility "X" averaged 782.4 cases per month; after August, 2005, it averaged 700.38 cases per month. As revealed by a regression model in which the independent variable, "Katrina," is dummy coded (prior to September, 2005 = 0; after August, 2005 = 1), the effect of Katrina is shown to result in 82 fewer cases per month. This effect is substantive and statistically significant, where "n of monthly cases" = 782.4 -82.025 *(Katrina), r^2 = .39, p <.001, which indicates a moderately strong regression model that is not due to chance.

Another way to examine the effect of Katrina on this caseload at Facility "X" is to look the underlying trend of the monthly number of cases from January, 2004 to August, 2007. As is shown by the least squares regression trend line in Fig. (**1**), the monthly number of cases is declining. Further analysis (discussed in Endnote # 1) reveals that this trend is statistically significant. That is, underlying the monthly variation in the number of cases over time, there is a declining trend in the number of cases at Facility "X." In summary, the analyses support the conclusion that the effect of Katrina was profound in that there are, on average, 82 fewer cases per month after Katrina and, moreover, that the number of monthly cases of this type at Facility "X" is likely to continue to decline into the foreseeable future.

The data on the candidates from the two service areas who presented themselves for the same medical procedure at

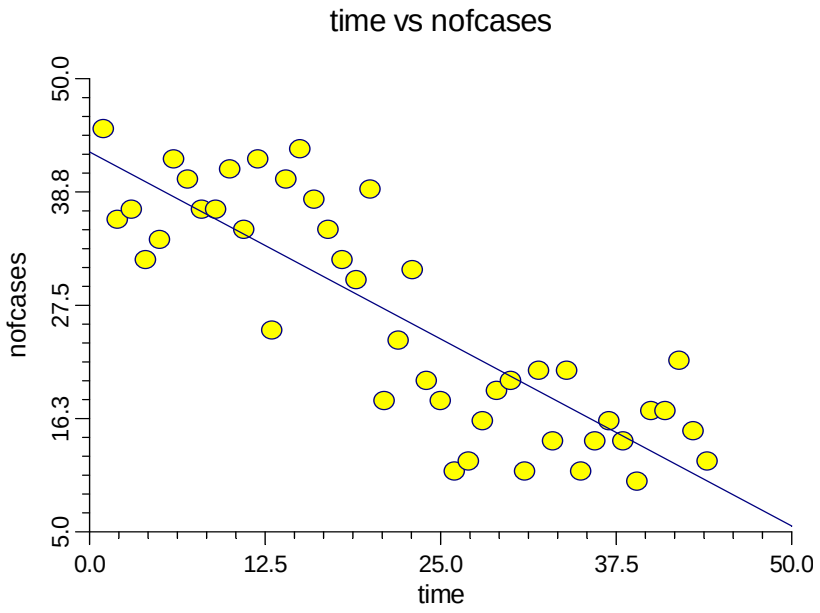

Fig. (2). The number of procedures performed at facility y related to the pool of potential medical procedure patients in the two service areas.

the medical provider's Facility "Y" are presented in Fig. (**2**). The number of cases is shown on the vertical axis and the time period (in months) is shown on the horizontal axis.

As is the case for the data presented in Fig. (**1**), the data in Fig. (**2**) represent a monthly time series (January, 2004 through August, 2007) of transactions of diagnostic codes (ICD 9) that are associated with the pool of patients who presented themselves for this procedure. As is the case for Facility "X" (Fig. **3**), the data for Facility "Y" (Fig. **2**) show a distinct break between the pre-Katrina months and the post-Katrina months: there is a distinct break around the point on the horizontal axis that represents the time period in which Katrina stuck (August of 2005 is represented by where point 19 would be located, which appears between 12.5 and 25 as shown on the horizontal axis). Prior to September, 2005, Facility "Y" averaged 37 cases per month; after August, 2005, it averaged 16.8 cases per month. As revealed by a regression model in which the independent variable, "Katrina," is dummy coded (prior to September, 2005 = 0; after August, 2005 = 1), the effect of Katrina is shown to result in 20 fewer cases per month.[2] This effect is substantive and statistically significant, where "monthly n of cases" = 37 -20.17 *(Katrina), r^2 = .81, p <.001, which indicates a strong regression model that is not due to chance.

The effect of Katrina on this caseload at Facility "Y," as can be seen by looking at the underlying trend of the monthly number of cases from January, 2004 to August, 2007, reveals a pattern similar to that found for these same types of cases in Facility "X." The least squares regression line in Fig. (**2**) shows that prior to the onset of Hurricane Katrina at the end of August 2005, the number of cases is distinctly higher than the time series subsequent to the onset of Katrina and that there is a declining trend in the number of cases at Facility "X." Again, this is supported by a statistically significant regression model (As described in Endnote # 2). In summary, the analyses support the conclusion that the effect of Katrina on these types of cases at Facility "Y" was profound in that there are, on average, 20 fewer cases per month after Katrina and, moreover, that the monthly number of cases of this type at Facility "y" is likely to continue to decline into the foreseeable future.

DEMOGRAPHIC EFFECTS AND MEDICAL PROVIDERS

There is a high level of correspondence between the population data, especially the population aged 55+ (Tables **1** and **2**) and the medical procedure data (Figs. **3** and **4**) that show that Katrina had a measurable effect on the pool of patients who would present themselves for the medical procedure in the two service areas (primary and secondary) associated with facilities "X" and "Y." The effects can be quantified as follows:

(1) Prior to Katrina, at Facility "X," there was an average of 782 cases monthly associated with the pool of patients who would present themselves for the medical procedure; after Katrina, this number was reduced by 10% to approximately 700. At Facility "Y," the Pre-Katrina monthly average of 37 of these types of cases was reduced by 55% to approximately 17. Combined, these reductions come to about 13%, from 819 to approximately 717.

(2) The population from which these patients were drawn is largely in service areas 1 and 2. Katrina reduced the 2007 total population in these two areas by 15%, from the expected number of 225,228 to the estimated number of 191,060. Katrina reduced the 2007 population 55+ in these two areas by 13%, from the expected number of 51,632 to the estimated number of 44,977.

SUMMARY

Although this is a case study for a specific area, the estimates presented here suggest that at least in the case of

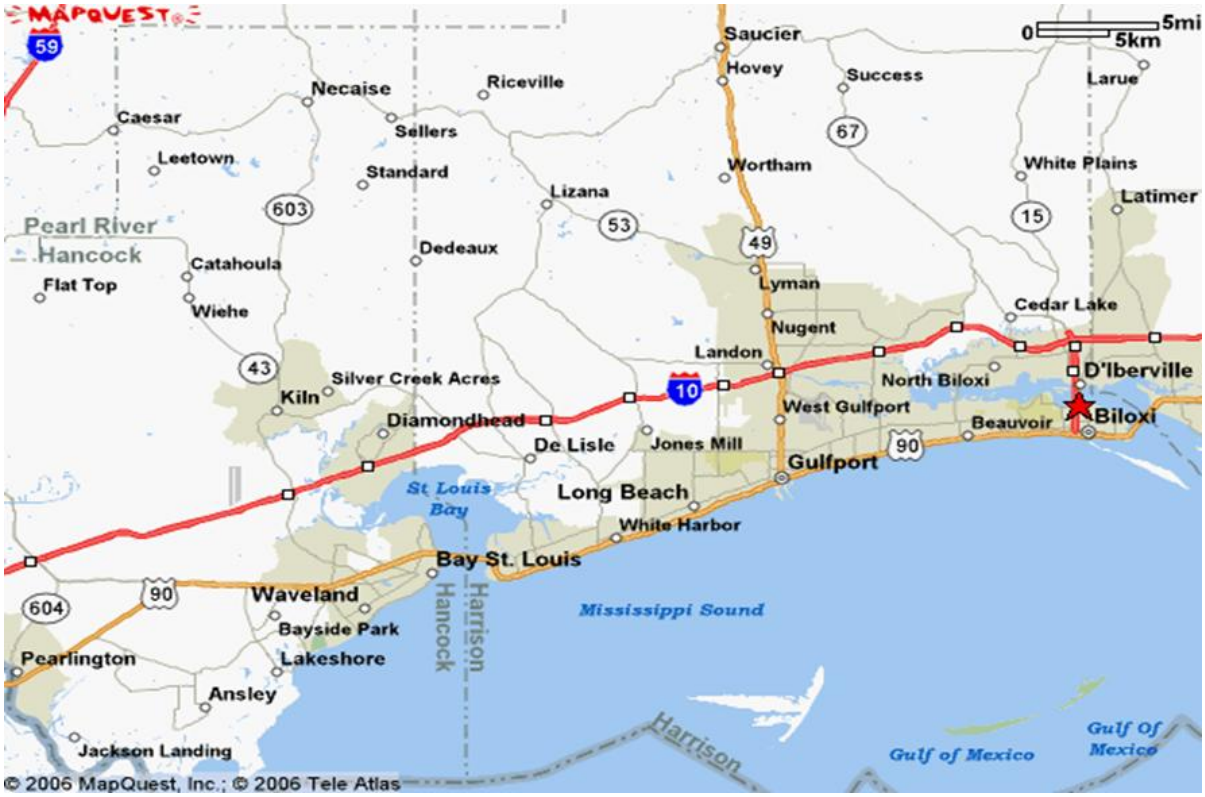

Fig. (3). The geographic context of the nsf study area.

Katrina's impact on the Mississippi gulf coast, the effects of a disaster can have substantial impacts on medical care providers not only during the relief and recovery phases, but well beyond them. The estimates presented here show that Katrina had a substantial demographic impact, which in turn impacted the client base underlying both of the medical facilities examined in this case study. As such, the results suggest that the effects of a disaster can have substantial impacts on medical care providers and their ability to continue business. In a broader look, Swanson [17] argues that the demographic effects of Hurricane Katrina on the Mississippi gulf coast will be long-lasting. In a similar vein, Cossman [23] finds that "agents of delay" have served to extend Katrina's effects on this same area and he argues that these same agents will be associated with future disasters, both natural and man-made.

The first step in effectively dealing with a disaster is the presence of a plan. As noted by Sokura and Cosby [24], it is typical of organizations to have both "disaster recovery" plans and "business continuation" plans. Given the long term demographic effects of Katrina that are suggested in this case study and estimated elsewhere [16, 17], it would seem that medical care providers at risk to large scale disasters should not only develop these types of plans, but to include in them, both estimates of both short and long-term demographic impacts.

In addition to disaster recovery and business continuation plans, the findings in this case study lead to three primary suggestions:

(1) medical providers themselves should be prepared to deal with the adverse affects of a disaster not only on their physical structures and staff, but also on the client populations they serve in terms of the entire disaster horizon;

(2) recovery agencies need to understand that the loss of client populations represents a major problem to medical care providers that has not been adequately addressed; and

(3) accountants, litigators, financial planners, and actuaries need to be cognizant of the fact that the loss of client populations are likely to have more of an impact on the business activities of medical providers than actual physical damage, which suggests that more research needs to be done in this area by medical sociologists and demographers.

APPENDIX

Demographic Data and Methods

The 2007 Katrina-impacted population estimates are based on data from three sources, PINEY BOWES MAPINFO, the US Census Bureau, and data collected under grant #0555136 from the US National Science Foundation.

Pitney Bowes MAPINFO Data. MAPINFO (Now part of Pitney Bowes, Inc.) is an international corporation that provides demographic and related information for clients in the private and government sectors (http://www.mapinfo.com/location/integration). One of the primary products of companies like MAPINFO is the provision of demographic information by zip code. For this project, Pitney Bowes MAPINFO provided 1990 and 2000 population data by age and sex for the 12 zip codes comprising the two service areas.

Census Bureau Data. In late 2006, the US Census Bureau [22] developed a set of special population

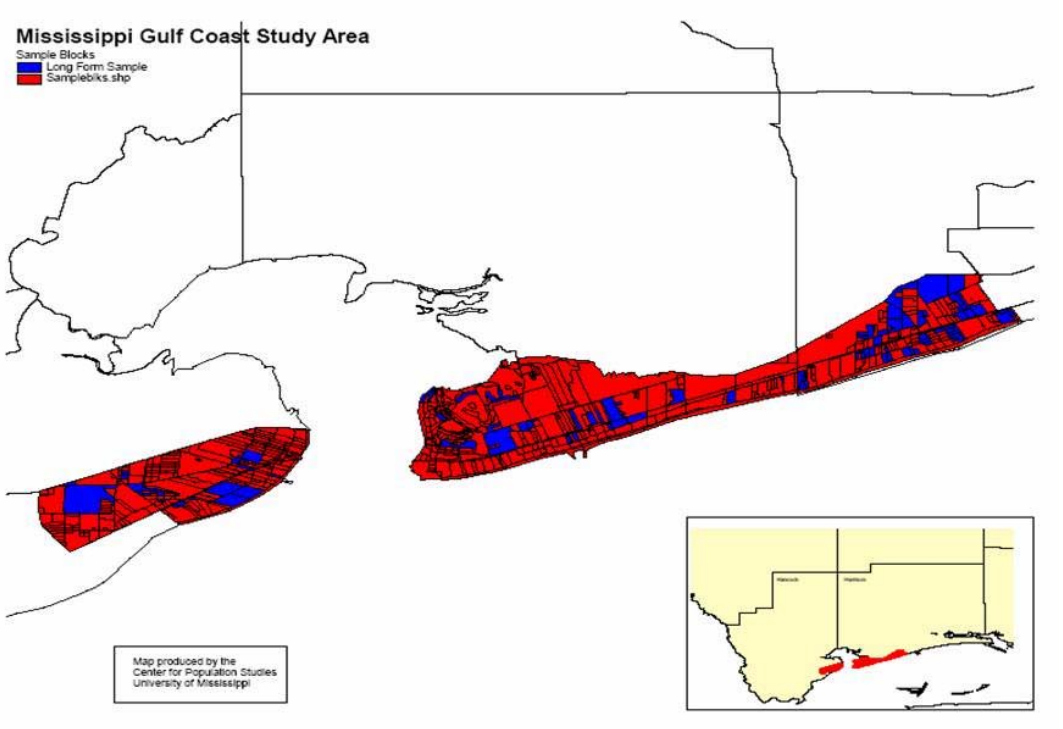

Fig. (4). The NSF study area and its target blocks.

estimates for counties impacted by Hurricane Katrina (http://www.census.gov/Press-Release/www/emergencies/impacted_gulf_estimates.html). The January 1st, 2006 population estimate for Harrison County, Mississippi is 155,871. In 2000, the population of Harrison County was determined by the US Census Bureau to be 189,601.

Data Collected under NSF Grant # 0555136. The "census tract" level data used in this report to make adjustments to selected zip codes. For zip codes 39501, 39507, 39525, and 39560, data collected in census tracts 27 and 28, Harrison County, were used. For zip code 39520, data collected in census tracts 301 and 302, Hancock, County, were used. For zip code 39571, data collected in census tracts 39 and 30, Harrison County, were used. These census tract data were gathered under the auspices of one of nine post-Katrina research projects funded by the National Science Foundation under the provisions of the SGER program.[3] Specifically, the data reported here are taken from work done by the recipients of SGER Grant #0555136, which:

(1) gathered pre- and post-Katrina information on housing and population from 573 targeted census blocks at the epicenter of Katrina's impact on the Mississippi gulf coast that the 2000 census showed as containing people (the "Short Form"); and

(2) employed a random start, systematic selection, cluster sample targeting 126 of these 573 blocks for administration of a 115-item questionnaire (the "Long Form"), such that at least 350 completed questionnaires would be obtained. The Long Form was designed for several purposes, one of which was to collect retrospective information on the roles that social and kinship networks played in determining respondents' success (i.e., the capacity for respondents to sustain their physical and emotional well-being after Hurricane Katrina).

The geographic context of the Study Area for NSF SGER Grant # 0555136 is provided in Fig. (**3**) and, the specific blocks are shown in Fig. (**4**). Full details of the data collection are found in Swanson *et al.* [18]. A brief description is as follows.

The primary data collection team included faculty and graduate students from the University of Mississippi, Mississippi State University, the University of Southern Mississippi, and the University of Tennessee Medical Center (Memphis), as well as several residents from the MS Gulf Coast. A secondary team was comprised of members of the geography division of the U.S. Census Bureau. This team geocoded selected sites and assisted with Short Form data collection. Collectively, the primary and secondary team members canvassed the Study Area to count and assess housing using a "Short Form" and to administer a "Long Form" Questionnaire. The team was successful in collecting Short Form data comprised of 10,547 completed surveys from 346 of the targeted 573 blocks and Long Form data comprised of 400 completed surveys from 71 blocks, 68 of which were from the 126 blocks targeted for Long Form data collection and three of which were from Short Form blocks erroneously canvassed.

The data collection process also captured information needed to provide a general assessment of survey data quality [25, 26]. Using these criteria, the assessment suggested that the data are of good quality.

The Short Form contained identifying information (housing unit sequence number, block, tract, and as much information on a street address as possible) and captured

four pieces of information: structure type (single or multiple unit dwelling, trailer, mobile home), whether it was permanent or temporary, its condition (habitable, heavily damaged, destroyed), and its occupancy status (occupied or vacant). The Short Form was approved for use by the Institutional Review Board of the University of Mississippi in the late fall of 2005. Short Form data were collected during two periods, January 8th to 15th, 2006 and March 10th to 19th, 2006, with the bulk of data being collected during the March 10th to 19th period.

The Short Form data (N=10,547) represent a complete enumeration of all housing in the 346 blocks, both permanent and temporary, as well as a determination of their condition (habitable, damaged, or destroyed) and occupancy status. These 346 blocks represent portions of two census tracts in Hancock County, MS (03010 and 03020) and four in Harrison County, MS (02700, 02800, 02900, & 0300), areas that were at the epicenter of Katrina's Landfall in Mississippi.

Because census definitions and conventions were used, the Short Form (and the corresponding control sheets for the Long Forms in a given block) allow for a direct comparison of housing unit counts obtained in the study with Census 2000 housing unit counts on a block-by-block basis. From this, virtually all housing stock change can be accounted for between census 2000 (officially, the date is April 1st) and August 29th, 2005. This allows not only for a comparison of pre- and post-Katrina housing, but also pre-and post-Katrina household populations.[4, 5, 6]

The Long Form was a self-administered questionnaire containing 115 items regarding sources, constraints, and assessments of Hurricane Katrina relief and recovery as well as basic demographic information, the latter of which used census definitions and conventions in the same manner as the Short Form described earlier. It was approved by the Institutional Review Board (IRB) at the University of Mississippi in the late fall of 2005. Each block in the Long Form sample, had a Control Sheet corresponding to the items found in the Short Form. The Long Form was informally tested and revised nine time before a formal pre-test was done in the field. This field pre-test also allowed the study team to assess and refine protocols and procedures associated with the data collection effort.

As stated earlier, it was administered to a representative sample comprised of 126 targeted blocks of the total of 573 in the Study Area. Seventy-one of these blocks were found to contain habitable housing. Team members went door-to-door handing out questionnaires and arranging with respondents a time to return for the completed questionnaire. A minimum of two callback attempts was made at each housing unit canvassed that potentially was occupied, including damaged permanent units and all temporary units.

The Long Form data were collected January 8th to 15th, 2006, with mail–out/mail-back callbacks collected from January 8th to February 15th. Four hundred completed Long Forms were obtained from canvassing and callbacks.

The data collected under the NSF SGER study were matched geographically to the zip code areas reported earlier. The matches are not exact but the data reported here come from blocks within them and are representative of the zip codes to which they are matched.

The housing unit counts described in this report were taken from the "short form" data. The population estimates found in the census tract files were generated by the "Housing Unit Method," a generally accepted technique used by demographers (Bryan, [27] 2004). The full form of the Housing Unit Method is defined as:

$$P = GQ + (PPH)(H)(OR)$$

where

P = Total Population

GQ = Population in Groups Quarters

PPH = Persons Per Household

H = Total Number of Housing Units

OR = Occupancy Rate

Note that (H)(OR) = Total Number of Households and

That (H)(OR)(PPH) = Population in Households

The Housing Unit Method (HUM) implemented here was used to estimate the population in households ((H)(OR)(PPH)= Household Population). The 2006 counts of housing units and occupied housing units are taken directly from the data collected under the auspices of the NSF SGER study (Short form data) as was the Persons Per Household (Long form data). The 2005 counts of housing units and occupied housing units were developed by combining the counts of destroyed and habitable housing found in the NSF SGER study to reconstruct the counts of total housing units. The 2000 census provided the occupancy rate and Persons Per Household used to estimate the 2005 household population in conjunction with the reconstructed housing unit counts. The 2000 counts of housing units and occupied housing units were taken from the 2000 census.

The following steps were used to develop the 2007 population data found in Tables **1** and **2**.

Step 1. The 1990 and 2000 populations by age and sex (purchased from PITNEY BOWES MAPINFO) were used to generate "cohort change ratios" (Smith, Tayman, and Swanson, [21] 2001: 127-128) for the population in each of the 12 zip codes.

Step 2. The cohort change ratios (CCRs) were then applied to the 2000 populations (by age and sex) of each of the 12 zip codes to generate 2010 populations by age and sex.

Step 3. The 2010 age and sex data were interpolated to get 2007 age and sex data. The interpolation used a factor of 0.7 to weight the number in a given age group generated for 2010 in the preceding step and a factor of 0.3 to weight the number of people in the same age group found in 2000. The two weighted numbers were then added together to obtain the interpolation for the age group in question for 2007.

Step 4. Once the interpolated age groups were obtained, the results were either adjusted in accordance with estimates of Katrina's demographic impact as found at the county level by the US Census Bureau or in accordance with the

block/block group/census tract level in the study funded by the National Science Foundation. The decision about which adjustment factor to use was based on geography.

(Step 4) Census Bureau Adjustment. For those zip codes that did not contain any of the areas covered by the National Science Foundation grant, the US Census Bureau estimates were used as adjustment factors. Zip codes to which this adjustment was applied include 39503 and 39574 in Service Area 1 and 39532, 39573, and 39577 in Service Area 2. The adjustment factor is $(155{,}817)*(155{,}817/189{,}601)^{(1/6)}$, where 155,817 is the population of Harrison County, as estimated by the US Census Bureau for January 1st, 2006, and 189,601 is the population of Harrison County, as counted in census 2000. By taking the ratio of the 2006 population to the 2000 population to the $1/6^{th}$ power, the geometric rate of change is found (.968). Multiplying this rate by the 2006 population of 155,817 yields 150,803, the estimated population of Harrison County in 2007, as impacted by Hurricane Katrina. This value is then divided by the 2000 population (189,601) to get the ratio of 0.795, which is multiplied by the population in a given age sex group as found in step 3.

(Step 4) NSF Adjustment. For those zip codes that did contain areas covered by the National Science Foundation grant, data from the study were used as adjustment factors. Zip codes to which this adjustment was applied include 39501 in Service Area 1 and 39507, 39520, 39525, 39560, and 39571 in Service Area 2. For zip codes 39501, 39507, 39525, and 39560, data from census tracts 27 and 28 in Harrison County were used. Specifically, it was found that the 2006 household population in the blocks of these two census tracts covered in the NSF study found a population of 4,554 compared to the 2000 population of 5,646. The number in each age/sex group as found in step 3 was multiplied ratio 4,554/5646 to get the final age-sex numbers for 2007 in these four zip codes. For zip code 39520, data from census tracts 301 and 302 in Hancock County were used. Specifically, it was found that the 2006 household population in the blocks of these two census tracts covered in the NSF study found a population of 2,855 compared to the 2000 population of 2,915. The number in each age/sex group as found in step 3 was multiplied by the ratio 2,855/2,915 to get the final age-sex numbers for 2007 in zip code 39520. For zip code 39571, data from census tracts 29 and 30 in Harrison County were used. Specifically, it was found that the 2006 household population in the blocks of these two census tracts covered in the NSF study found a population of 970 compared to the 2000 population of 3,669. The number in each age/sex group as found in step 3 was multiplied by the ratio 970/3,669 to get the final age-sex numbers for 2007 in zip code 39571.

Medical Procedure Data and Methods

The medical procedure data were made available by a provider. The data are not described in detail (e.g., the type of procedure) as a means of preserving the provider's confidentiality. The data are in the form of two sets of monthly time series representing transactions of diagnostic codes (ICD 9) representing candidates presented themselves for a specific medical procedure. The time series data are analyzed using regression models as described in the text and endnotes 1 and 2.

ENDNOTES

1. The regression model indicated for the data from Facility "X" (time is the independent variable and the number of cases is the dependent variable) is statistically significant with the following characteristics:

N of Monthly Cases = 814.00 – 3.39*time ($r^2 = .43$, $p < .01$)

2. The regression model indicated for the data from Facility "Y" (time is the independent variable and the number of cases is the dependent variable) is statistically significant with the following characteristics:

N of monthly Cases = 42.72 – 0.74*time ($r^2 = .72$, $p < .01$)

3. The work supported by the National Science Foundation under Grant No. 0555136 was awarded to the University of Mississippi (D. Swanson (then in the Department of Sociology & Anthropology at the University of Mississippi), PI; Mark Van Boening (Economics) and Rich Forgette (Political Science), Co-PIs). The Acronym "SGER" stands for "Small Grants for Exploratory Research." Very soon after Katrina struck the Mississippi Gulf Coast, The National Science Foundation issued a call for "SGER" grants to assess its impact.

4. The definition of a housing unit follows that of the Census Bureau's definition as used in the 2000 Decennial Census. However, the Census Bureau has no definition for a "damaged" or "destroyed" housing unit. Given the intent of the study, such a definition was needed. Therefore, a "damaged housing unit was defined as one that had received observable damage, but was still standing and appeared to be structurally sound. For example, a house with a blue tarp for a roof and all of the doors, windows, and interior walls missing was defined as damaged. A destroyed house was one that was either completely gone (e.g., only a slab remained) or sustained structural damage (e.g., supporting beams for the roof had collapsed, a wall was caved in). In cases where it was difficult to distinguish whether a house was damaged or destroyed, it was classified as damaged.

5. The Census Bureau does not distinguish between a temporary and permanent housing unit. Specifically, the Census Bureau defines a housing unit as a shelter intended for "separate use' by its occupants such that there is independent access to the outside and the shelter is not a group quarters (Swanson and Stephan, [28] 2004: 762). Given the intent of the study, temporary housing units needed to be identified. Therefore, we defined temporary housing units using the following protocol. First, temporary housing units were defined as any non-permanent structure in which people were residing. This included tents, lean-to, campsites, motor vehicles, recreational vehicles, travel trailers, house trailers and mobile homes with their axles and wheels in place. The recreational vehicles, travel trailers, house trailers, and mobile homes classified as temporary housing units generally were on lots next to destroyed or damaged permanent housing units or in parks and usually were connected to power and other utilities. In such cases, even if they were not occupied, we counted them as temporary housing units. If tents, cars, and trucks were encountered that were not occu-

pied, they were not counted as housing units. Similarly, unoccupied recreational vehicles, travel trailers, house trailers, and mobile homes on sales lots were not counted (These were usually either heavily damaged or destroyed anyway).

6. The household population is comprised of those who live in housing units (as opposed to those who are homeless or living in group quarters – prisons, long-term care hospitals, military barracks, and school and college dormitories (Swanson and Stephan [28], 2004: 762).

ACKNOWLEDGEMENTS

*The author thanks Mary McGehee and Richard Verdugo for comments and Ken Hodges of CLARITAS and Angelina Tofolli and Tom Exter of Pitney Bowes MAPINFO for assistance in obtaining zip code level data. This material is partly based upon work supported by the National Science Foundation under Grant No. 0555136. Any opinions, findings, and conclusions are those of the author and do not necessarily reflect the views of the National Science Foundation.

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Received: February 27, 2009 Revised: March 05, 2009 Accepted: March 10, 2009