
Post-Katrina Mortality in the Greater New Orleans Area, Louisiana

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Objectives: Death rates in the Greater New Orleans area were examined by month from 2002 to 2006 to assess whether mortality increased after Hurricane Katrina.

Methods: Finalized death data from the Louisiana Office of Vital Statistics and the most recent population estimates were used to calculate annual mortality rates in the Greater New Orleans area by month for 2002-2006. Causes of death were also examined for changes.

Results: There was no significant increase in the death rates in the Greater New Orleans area post-Katrina. The only excesses were seen in Orleans Parish from January to June 2006. In the latter months of 2006, rates decreased to those of previous years. Mortality rates for the Greater New Orleans (GNO) area during the same time period showed no increase. In the first months of 2006, deaths due to septicemia and accidents increased significantly in Orleans Parish and returned to normal in the latter half of 2006. Causes of death in the GNO area showed no significant change after Katrina.

Conclusions: There was no significant or lasting increase in mortality rates in the Greater New Orleans area following Hurricane Katrina.

INTRODUCTION

Hurricane Katrina made landfall on the Gulf Coast in August 2005. In the aftermath of the storm, over one million residents of Greater New Orleans (GNO) were displaced when 80% of the city was flooded for more than three weeks. As GNO recovers from the storm and residents repopulate the area, concerns have been expressed about excess post-Katrina mortality.¹ The goal of this report is to address these concerns.

In the absence of finalized death data and with sparse estimates of a rapidly changing population, a 50% increase in mortality in GNO was widely reported in the media.²⁻⁵ Since that time, we have obtained final death data from the Louisiana Office of Vital Statistics through 2006. Using these data with refined population estimates, annual death rates were calculated by month.

POPULATION & METHODS

This report is based on final data from the Section of Vital Statistics of the Louisiana Office of Public Health, Department of Health and Hospitals through 2006. To provide historical perspective, data from 2002 onwards are presented.

We analyzed all deaths recorded in the 10 parish GNO area (including Orleans, Jefferson, St. Bernard, Plaquemines,

St. James, St. John, St. Charles, St. Tammany, Tangipahoa and Washington parishes), East Baton Rouge Parish and the remaining Louisiana parishes. Death records contain detailed demographic information as well as immediate cause of death coded according to the International Classification of Diseases, 10th revision. Causes of death were grouped following the model used in National Vital and Health Statistics Reports issued by the Centers for Disease Control.⁶

Data are presented by month to deal with missing population data for September through December 2005.

Estimates of population are now available so that crude mortality rates can be calculated, although some of the estimates may not represent the actual population number. Population data for January 2002 to August 2005 are based on the 'Annual Estimates of the Population for Counties (Parishes) of Louisiana'.⁷ The population estimates for January 2006 are those of the US Census Bureau on Population Estimates for Impacted Counties in the Gulf Coast Areas.⁸ The Greater New Orleans Community Data Center and the Louisiana Public Health Institute (LPHI) conducted a household population survey to estimate the July 2006 population.⁹ Population for the months between January and July 2006 was calculated using the difference between the two estimates and assuming a linear monthly increase in population. Whenever available, population data for July 2006 onwards were calculated using July 2005 population data and the percentage change in households receiving mail by month.¹⁰

Annual mortality rates per thousand population were calculated for each month. Rates were not calculated for the period September 2005 through December 2005 since population estimates are unreliable. Because the post-Katrina population varied tremendously from month to month in many parishes, monthly mortality rates provide a clearer picture of mortality trends than annual data.

The numbers of deaths are based on the parish of residence. When calculating a rate it is imperative that the numerator (number of deaths) and denominator (parish population) are included in the same population. The denominator is the estimate of the number of people residing in the parish. The numerator must then be the number of deaths among parish residents. Louisiana Vital Statistics data include all people who die in Louisiana; consequently this report does not address the death of those Louisiana residents who have died out of state. The parish residence code listed in the death record was used to count the number of deaths in a given parish. Out of state residents who died in Louisiana are not included in this report.

Because this study was done to determine whether there was an increase in mortality in 2006, it was important not to underestimate the number of deaths by parish of residence. It appeared that some death records in the raw data were missing data on parish of residence. To include these residents in our analysis, an adjustment was made using the following algorithm. This algorithm was applied to the variable "Parish of Residence".

1. Use Parish of Residence when present.
2. When not listed, use parish of the city listed in the address of the deceased.
3. When not listed, use parish of the zip code listed in the address of the deceased.
4. When not, listed use parish of death.

With this algorithm, missing parish of residence was reduced from 566 records to 33.

To address the hypothesis that there have been an excess number of deaths in Louisiana due to Orleans Parish residents who have relocated to Louisiana parishes outside of the GNO area, mortality rates for East Baton Rouge Parish and the remaining Louisiana parishes were calculated.

RESULTS AND COMMENTS

The GNO Area

There was a marked decrease in the total number of deaths that occurred in the GNO area post-Katrina. In 2006, 10,321 deaths were recorded in the 10 parish GNO area, a reduction of 28% over previous years. Because of the post-Katrina population decrease, the 2006 reduction in the number of deaths is expected. The annual death rates per 1,000 population by month are much better at describing the mortality in the GNO area since there were large shifts in population (Table 1).

We compared the mean death rates in the Greater New Orleans area (GNO) for January through June 2002-2005 and

Table 1. Annual death rates per 1,000 residents in the Greater New Orleans (GNO) area by month-Louisiana, 2002-2006.

GNO	2002	2003	2004	2005	2006
Jan	10.8	10.5	10.4	10.3	10.6
Feb	9.1	8.8	9.5	10.4	9.4
Mar	10.5	10.0	10.5	10.3	10.1
Apr	8.9	9.6	9.6	9.1	9.4
May	9.3	9.6	9.0	9.7	9.2
Jun	9.3	9.2	9.4	8.9	8.5
Jul	9.3	8.7	9.4	9.1	8.0
Aug	9.7	9.3	9.5	15.2	8.0
Sep	8.9	9.5	9.1	*	7.6
Oct	9.1	9.6	9.6	*	7.6
Nov	9.6	9.3	8.7	*	6.9
Dec	10.2	10.2	10.2	*	4.8
Total	9.6	9.5	9.6	*	8.8

*Incomplete population data, rates not calculated.

2006. The mean GNO death rate for January through June for the years 2002-2005 was 9.7 deaths per 1000 population. The mean death rate from January through June 2006 was 9.5. A paired t-test yielded a difference of means equal to 0.1667 (95% CI -0.1700, 0.5033; $p=0.2591$); this difference is not significant.

We compared the mean death rates for July through December for the years 2002-2004 with the death rates in 2006. The last half of 2005 was not included due to the unavailability of reliable population data. The mean death rate for July through December 2002-2004 in the GNO was 9.4; in 2006 it was 7.2. The difference of means was 2.2883 (95% CI 0.6376, 3.9391; $p=0.0162$). Using this data, mortality rates were significantly lower during July through December 2006 in the GNO area than during the same months of 2002-2005.

In parishes where the 2006 population rebounded quickly or was relatively unaffected by Katrina (St. Charles, St. James, St. John, St. Tammany, Tangipahoa and Washington parishes), the number of deaths does not show a difference in the first few months of 2006. However other parishes still have large differences in pre-versus post-Katrina population: Orleans Parish lost 66% of its population; St. Bernard, 60%; Plaquemines, 40%; and Jefferson, 10%. For these parishes it is imperative to look at the death rates by month (Table 2).

Orleans Parish

In Orleans parish during the first six months of 2006, there was an excess mortality of 21% with an average of 13.0 deaths per 1,000 population versus 10.8 per 1,000 population for the same six month period of 2002-2005 (Table 2). When compared with a paired t-test, this difference was significant (difference of means equal to -2.233; 95% CI -3.559, -0.908; $p=0.0075$).

Table 2. Annual death rates per 1,000 residents per year by parish of residence in the Greater New Orleans (GNO) area by month-Louisiana, 2002-2006.

Orleans	2002	2003	2004	2005	2006	Plaquemines	2002	2003	2004	2005	2006
Jan	12.4	12.0	11.3	11.3	15.8	Jan	5.3	8.2	7.5	11.2	6.5
Feb	9.8	10.2	11.1	11.4	13.8	Feb	5.3	9.0	10.8	9.1	5.2
Mar	12.2	10.9	12.0	10.8	13.7	Mar	8.3	8.2	9.5	7.0	9.1
Apr	10.0	10.5	9.8	10.4	11.7	Apr	7.5	11.2	6.6	7.4	3.9
May	10.3	10.8	10.3	10.7	12.6	May	11.4	6.9	5.4	6.6	10.3
Jun	10.4	10.0	10.5	9.3	10.5	Jun	7.9	7.3	7.9	8.3	9.6
Jul	10.6	10.4	11.2	9.7	11.1	Jul	7.5	4.7	7.5	6.6	3.7
Aug	10.5	9.6	10.7	25.6	9.7	Aug	10.1	5.6	7.9	7.4	8.0
Sep	10.1	10.6	10.6	*	8.5	Sep	7.9	8.2	8.3	*	5.3
Oct	10.3	10.4	10.3	*	8.6	Oct	7.5	8.6	9.1	*	6.4
Nov	10.4	10.0	10.6	*	7.9	Nov	7.0	8.2	7.0	*	5.3
Dec	11.0	12.0	11.9	*	8.8	Dec	10.1	11.6	5.8	*	4.8
Total	10.7	10.6	10.9	*	10.7	Total	8.0	8.1	7.8	*	6.5
Jefferson	2002	2003	2004	2005	2006	St. Bernard	2002	2003	2004	2005	2006
Jan	10.6	9.6	9.7	10.1	10.1	Jan	13.0	14.4	15.0	11.9	22.4
Feb	9.5	8.1	8.8	10.4	8.5	Feb	9.9	12.4	11.2	13.0	16.2
Mar	11.1	9.6	10.2	11.2	9.4	Mar	11.0	13.3	14.6	13.4	13.1
Apr	8.7	8.9	10.1	8.5	9.5	Apr	14.1	11.7	11.2	15.1	9.3
May	9.5	9.7	8.4	9.9	8.6	May	9.4	11.8	13.2	12.5	18.6
Jun	8.9	9.2	9.0	9.2	8.4	Jun	12.5	12.8	13.2	11.4	8.5
Jul	8.5	8.1	8.3	9.1	6.9	Jul	12.3	8.9	10.4	11.6	19.3
Aug	9.6	9.5	8.6	9.2	7.5	Aug	10.8	13.1	10.8	33.0	12.4
Sep	8.7	9.2	8.6	*	8.5	Sep	10.7	11.5	12.1	*	17.0
Oct	8.1	8.9	9.3	*	8.8	Oct	11.4	11.1	11.0	*	13.9
Nov	9.2	9.2	8.1	*	8.8	Nov	10.7	12.2	11.5	*	11.6
Dec	10.2	9.9	9.7	*	8.6	Dec	12.8	12.4	11.7	*	15.5
Total	9.4	9.2	9.1	*	8.6	Total	11.6	12.1	12.1	*	14.8

From July to December 2006, death rates decreased in Orleans Parish to become similar to those of previous years. For the latter half of 2006, mortality rates in Orleans Parish were significantly lower than those of previous years (difference of means equal to 1.520; 95% CI 0.2580, 2.7820; p=0.0270). This could be a real effect or could be a result of an overestimation of the population of Orleans Parish.

Jefferson, Plaquemines and St. Bernard Parishes

No significant differences were found in pre-and post- Katrina mortality rates in these parishes. Population estimates, especially in St. Bernard and Plaquemines parishes, may not reflect the true population of these areas, affecting calculated mortality rates.

East Baton Rouge Parish and the Rest of Louisiana

All rates are well within expected ranges except for an increase of 13% in East Baton Rouge Parish for the first four months of 2006, with an average of 9.4 deaths per 1,000 population in 2006 versus 8.2 for the same months of 2002-2005. This difference is statistically significant (p=0.0181). When rates from January through July were examined, however, there was no significant difference.

The remaining Louisiana parishes showed no differences in mortality rates over the years examined.

Out of State deaths among pre-Katrina Orleans residents who moved out of state.

Although deaths among displaced GNO residents living out of state certainly merit some analysis, the Louisiana Department of Health and Hospitals (DHH) has no data on this population. It will be a very difficult task to reach definitive conclusions about this situation given that it will be impossible to collect accurate mortality and population statistics. If data collected on displaced persons out of state is inaccurate, it will lead to speculative conclusions.

Causes of Death

Louisiana has historically had higher mortality rates than the United States (Table 3). This trend is seen in all categories of causes of death both prior to and after August 2005.

The top 10 causes of death in the United States caused the majority of deaths in Louisiana, GNO, and Orleans Parish from 2002-2006. The ranking of the causes of death did not change in GNO or Orleans Parish post-Katrina (Table 3). From January through July 2006, GNO and Orleans Parish exhibited increased rates of mortality in all causes compared to August through December 2006 and pre-Katrina rates.

Table 3. Death rates per 1,000 residents per year for common causes of death, United States, Louisiana, Orleans Parish, and the Greater New Orleans (GNO).

January- July Causes of Death (per 1000 population)						
	USA all 2003⁶	Louisiana all 2002¹²	Orleans 2002-2005	Orleans 2006	GNO 2002-2005	GNO 2006
Diseases of the heart	2.36	2.48	2.08	2.76	2.03	2.25
Malignant neoplasms	1.92	2.10	2.03	2.33	1.88	2.01
Cerebrovascular diseases	0.54	0.57	0.63	0.72	0.51	0.52
Chronic lower resp. diseases	0.44	0.47	0.31	0.34	0.32	0.40
Accidents	0.38	0.40	0.27	0.51	0.40	0.61
Diabetes mellitus	0.26	0.38	0.52	0.62	0.41	0.37
Influenza and pneumonia	0.22	0.21	0.14	0.17	0.15	0.16
Alzheimer's disease	0.22	0.25	0.21	0.35	0.22	0.25
Nephritic diseases	0.15	0.22	0.25	0.28	0.21	0.26
Septicemia	0.12	0.18	0.19	0.38	0.16	0.20
Intentional self harm (suicide)	0.11	--	0.08	0.12	0.10	0.11
Chronic liver diseases/ cirrhosis	0.09	0.38	0.09	0.10	0.08	0.09
Essential hypertension and hypertensive renal disease	0.08	--	0.07	0.15	0.06	0.10
Parkinson's disease	0.06	--	0.06	0.08	0.06	0.06
Assault (homicide)	0.06	--	0.47	0.57	0.20	0.18
August- December Causes of Death (per 1000 population)						
	USA all 2003⁶	Louisiana all 2002¹²	Orleans 2002-2004	Orleans 2006	GNO 2002-2004	GNO 2006
Diseases of the heart	2.36	2.48	2.37	1.96	2.33	1.95
Malignant neoplasms	1.92	2.10	2.32	1.76	2.16	1.78
Cerebrovascular diseases	0.54	0.57	0.63	0.54	0.54	0.43
Chronic lower resp. diseases	0.44	0.47	0.32	0.23	0.34	0.27
Accidents	0.38	0.40	0.26	0.30	0.44	0.41
Diabetes mellitus	0.26	0.38	0.64	0.23	0.48	0.33
Influenza and pneumonia	0.22	0.21	0.13	0.13	0.14	0.14
Alzheimer's disease	0.22	0.25	0.28	0.23	0.27	0.21
Nephritic diseases	0.15	0.22	0.34	0.20	0.27	0.18
Septicemia	0.12	0.18	0.24	0.09	0.19	0.13
Intentional self harm (suicide)	0.11	--	0.08	0.11	0.10	0.10
Chronic liver diseases/ cirrhosis	0.09	0.38	0.12	0.06	0.09	0.08
Essential hypertension and hypertensive renal disease	0.08	--	0.08	0.10	0.08	0.09
Parkinson's disease	0.06	--	0.08	0.04	0.07	0.06
Assault (homicide)	0.06	--	0.53	0.60	0.25	0.21

We did further research into causes of death that appeared to increase in frequency in Orleans parish during the first seven months of 2006 (Table 4). After paired t-test calculations for annual mortality rates by month for January through July 2002-2005 and 2006, we found that deaths due to septicemia and accidents increased significantly while

those attributed to suicide, essential primary hypertension and hypertensive renal disease, and homicide did not. However, in the latter half of 2006, septicemia mortality rates fell to below pre-Katrina rates, and differences in pre- and post-Katrina mortality due to accidents were not significant.

Limitations and assumptions

The calculation of mortality rates relies on population numbers in the denominator. There are several population estimates. Besides those used in this article are the population estimates from GCR Associates which used a different methodology than the census surveys conducted by LPHI. GCR estimates for July 2006 were 16% higher than those used in this article (223,388 versus 191,139). Using their estimates would decrease the mortality rates by about 15%. Since the main controversy was about high death rates, the lower population estimates of LPHI were selected, not to artificially decrease the rates with high population estimates. There are uncertainties in the population estimates. It is likely that the influx of migrant population has been difficult to capture and probably underestimated. These migrant workers were probably in the younger age brackets, fairly healthy, and probably less likely to increase artificially the number of deaths.

Parish of residence is another limitation of this study. For example, the death certificate of someone who had evacuated from Orleans and lived temporarily in East Baton Rouge, making some trips back to Orleans, may list the parish of residence as Orleans or East Baton Rouge depending on where the death occurred and the information given at the time of hospital admission.

In general it seems that the effect of most limitations would be toward a higher population in the severely affected areas, thus a bias towards lower mortality rates.

CONCLUSION

It is undeniable that the hurricane had an enormous impact on all aspects of the lives of GNO residents. However, reports of increased mortality are erroneous and may mislead interested parties. This study does not support the widely cited claim that mortality in GNO rose by 47% in months following Hurricane Katrina. To the contrary, we did not find a significant increase in deaths in GNO, with the exception of a 21% increase in Orleans Parish during the first half of 2006. During the latter half of 2006, however, death rates in all parishes fell below pre-Katrina levels.

Hurricane Katrina highlighted the need for a method of quickly assessing the public health needs of disaster stricken regions. Unfortunately, in this situation there was no reliable method of calculating mortality in the absence of trustworthy data on deaths and population. As the field of public health emergency response evolves, research should be steered towards developing a means of accurately and rapidly estimating mortality.

A comparison of mortality rates showed little difference between before and after Hurricane Katrina. This should not be interpreted, however, as the absence of health problems. For a number of reasons the most severely chronically ill residents may not have returned immediately but may progressively return to an area with decreased availability of medical care. The healthy worker population may decrease after renovation and restoration jobs are no longer in abundance. Therefore, continuous monitoring of population health status and mortality are essential in the future.

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Table 4. Death rates per 1,000 residents per year for common causes of death in Orleans Parish by month, 2002-2005 and 2006.

	<u>septicemia</u>		<u>accidents</u>		<u>suicide</u>		<u>hypertension</u>		<u>homicide</u>	
	2002-2005	2006	2002-2005	2006	2002-2005	2006	2002-2005	2006	2002-2005	2006
January	0.29	0.76	0.28	0.61	0.08	0.08	0.06	0.00	0.45	0.15
February	0.14	0.51	0.27	0.36	0.10	0.07	0.10	0.29	0.47	0.44
March	0.26	0.35	0.31	0.56	0.09	0.14	0.06	0.21	0.50	0.28
April	0.27	0.27	0.22	0.27	0.06	0.27	0.06	0.00	0.56	0.81
May	0.24	0.33	0.39	0.59	0.10	0.20	0.06	0.26	0.54	0.91
June	0.23	0.44	0.30	0.63	0.10	0.06	0.07	0.06	0.65	0.38
July	0.12	0.12	0.40	0.54	0.08	0.00	0.11	0.24	0.57	0.89
diff of means	-0.1757		-0.1986		-0.0300		-0.0771		-0.0171	
95% CI	-0.3454 to -0.0060		-0.3016 to -0.0955		-0.1219 to 0.0619		-0.1847 to 0.0304		-0.2873 to 0.2530	
p value	0.0444		0.0033		0.4547		0.1298		0.8817	

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