

Adverse Health Outcomes after Hurricane Katrina among Children and Adolescents with Chronic Conditions

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Abstract: Children with chronic conditions may be at risk of increased disruptions in health care following natural disasters such as Hurricane Katrina. The objective of this cross-sectional study was to evaluate differences between children and adolescents with and without chronic conditions immediately following Katrina. Of 531 participants, there were 79.8% younger than 13 years old, 50.5% male, 42.8% African American. Participants with pre-existing conditions (39.4% of the total sample) were more likely than those without to be at the clinic for a non-chronic health condition rather than another problem (43.5 vs. 16.2%), to take asthma medication (37.4 vs. 3.9%), to have asthma worsen (16.3 vs. 1.9%), to miss a visit (49.2 vs. 39.8%), to run out of medications (33.9 vs. 7.9%), to live with flood damage (19.7 vs. 11.3%) or mold (23.6 vs. 15.8%), and to experience disruption in care (58.4 vs. 38.3%) or negative psychological consequences (ranging from 2.5% to 12.9%). While the medical differences are unsurprising, given the groups being compared, the other differences between the groups merit attention from policymakers and health care providers. Children and adolescents with chronic conditions are at increased risk of adverse outcomes following a natural disaster. Providers may be able to reduce negative effects on this population by developing condition-specific preparedness care mechanisms.

Key words: Children, adolescents, chronic conditions, Hurricane Katrina, disaster, outcomes, preparedness.

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Hurricane Katrina made landfall on the Gulf Coast of the United States on August 29, 2005, causing one of the country's most expensive natural disasters in terms of both financial and human losses.^{1,2} In New Orleans, the combination of wind, storm surge, and rainfall resulted in an undermining of the levee system and flooding of over 80% of the city by neighboring Lake Pontchartrain.¹ The impact of the hurricane on New Orleans, both immediate and over the subsequent year has been extensively chronicled.¹⁻¹²

Even in the absence of a natural disaster, children and adolescents—especially those with chronic health conditions—have specific needs and vulnerabilities at each developmental stage. Of the 469,032 residents of New Orleans at the time of Hurricane Katrina, an estimated 27% were under 18 years old.¹³ While children and adolescents will react differently to a disaster and its aftermath depending on age, developmental level, and prior experiences, much child functioning will be influenced by how parents and other caregivers respond to the stress of the disaster and their states of health. Often a caregiver's own mental state can greatly influence his or her parenting behaviors.¹⁴ In the face of stress, children can develop post-traumatic stress disorder (PTSD) and other mental health conditions. These may surface as depression, withdrawal, behavioral problems, hyperactivity, or delinquency. There can also be somatic manifestations of chronic stress.^{15,16} Children with pre-existing chronic conditions may experience adverse physical and psychological outcomes more than children without them in the face of stressors.

Disaster survivors with pre-existing chronic conditions may be particularly vulnerable when faced with specific disaster-related situations. For example, patients with immunodeficiency and AIDS may face increased susceptibility to opportunistic infections. People with chronic conditions may as a matter of course depend on health care specialists and on complex treatment regimens, diets, and other interventions. Not having shelter or usual routines can create more disruptions than arise for people without such conditions.¹⁷ Children and adolescents dependent on adult caregivers, especially children with special needs, may be particularly prone to adverse effects of evacuation and disruption of support systems and routines. Children and adolescents with special needs experienced increased morbidity and mortality also during Hurricane Andrew, which altered access to medications, physician contact, and routine care.¹⁸ In the United States, approximately 12.8% of children are classified as having special health-care needs, defined by the U.S. Maternal and Child Health Bureau as: "... those who have or are at increased risk for a chronic physical, developmental, behavioral, or emotional condition and who also require health and related services of a type or amount beyond that required by children generally."^{19, p.138} In addition, those requiring ventilation or other electronic life-support services may be even more affected, given power outages.²⁰

Few studies have been conducted to provide insight into the complicated needs of children and adolescents with pre-existing chronic conditions following natural disasters. The purpose of this study is to identify physical, utilization, and psychological outcomes among such children and adolescents after Hurricane Katrina. An improved understanding of the needs of children and adolescents following disasters may help foster improved continuity of care and more success meeting these patients' needs.

Methods

Data were collected from October to December 2005 by an anonymous cross-sectional survey administered to a convenience sample of children and adolescents. Consenting patients 0 to 24 years of age seen at health care facilities post-Katrina in the metropolitan New Orleans area were eligible if they had not taken the survey previously and they reported age and gender. A multidisciplinary team of pediatricians, researchers, social workers, psychologists, and behaviorists created the instrument, adapting items from several previously validated instruments (i.e., PTSD Questionnaire of the National Child Traumatic Stress Network and Louisiana State University, Department of Psychiatry; Project Liberty of the New York Crisis Counseling Program; the UCLA Reaction Index^{14,35}). Medical questions included an extensive checklist for self-reporting of symptoms pre- and post-Katrina. Question items included self-report status of acute and chronic conditions pre- and post-Katrina, health care utilization (i.e., well-child visits, immunizations), and evacuation experiences. Due to the conditions at the time of survey administration, validation with hospital records was not feasible and all data were via self-report by the caregiver or the respondent. All participants were informed of the purpose of the study and asked to participate when presenting at one of the select administration sites in New Orleans. The study sites included: 1) Children's Hospital of New Orleans, 2) Tulane Hospital for Children, 3) Ochsner for Children Ambulatory Care Center, 4) Covenant House (an organization for adolescents in need of care and shelter), and 5) private practices and city health clinics serving 0 to 24 year olds in the New Orleans Metro Area as well as the Charity Hospital Emergency Room (located at the New Orleans Convention Center). The survey was conducted while waiting for provider visits either by 1) the child/participant, 2) the parent/guardian for the child, 3) the child/participant with parent/guardian together, or 4) the child or guardian /parent with assistance by a volunteer/ health care professional. Participants indicating on the form that they had taken the survey before were excluded.

Univariate and bivariate analyses were performed to describe the study sample and evaluate potential confounders. To evaluate unadjusted associations between independent and dependent variables, chi-square tests were used for categorical variables and unpaired t-tests for continuous variables. Logistic regression was used to model unadjusted and adjusted relationships between predictors and outcomes of disruption of care and development of new symptoms or diagnoses. A goodness-of-fit test ($\alpha=0.15$) was used to assess model fit.

An individual was classified as having a chronic condition if they answered *yes* to having, diabetes, asthma, other chronic lung disease, allergies, HIV/AIDS, other immune disease, heart defect/disease, cystic fibrosis, mental retardation, attention deficit/hyperactivity disorder (ADHD), autism, depression, other mental health or behavior problems, seizure disorder, sickle cell disease, kidney failure/dialysis, or liver failure prior to August 2005. Disruption in routine care was defined as when the participant reported *yes* to either missed doctor's visits by self-report, ran out of medications, missed immunizations, or was not current in immunizations. Development of a new symptom or diagnosis occurred if the participant reported not having a condition prior to August 2005 yet had it in any one of the first four months following the hurricane. For the

panel of psychological response variables, participants reporting having a particular experience or outcome *much* or *most* of the time were considered to have a positive response. Facility was entered into the regression models as an indicator variable to assess specific differences between facilities. Stata, v. 9.0se (College Station, Texas) was used for all analyses. In this study, all instruments, consents, and modifications were approved prior to implementation by all governing institutional review boards (IRB) (Children's Hospital, Tulane Hospital, George Washington University, and Ochsner Hospital and Clinic).

Results

Between October and December 2005, 601 surveys were completed. Of these, 531 were eligible [reasons for exclusion: invalid age: 42 (7.0%); no gender: 12 (2.0%); taken before: 16 (2.7%)]. As seen in Table 1, the majority of the children were younger than 13 years old (79.8%) [median 5.33 years, mean age 6.9 years (standard deviation 5.6, range 0.08–24)] and seen at the Children's Hospital of New Orleans (one of the first facilities to re-open after the hurricane) (72.9%). The sample was approximately half male (50.2%) and nearly half African American (42.8%). Nearly half of the children were seeking medical care for a new problem (47.1%), and the remainder for an existing problem (28.3%) or a well-child visit (14.5%). Almost half of the children had one or more chronic conditions prior to Hurricane Katrina (43.2%). Most (81.0%) had evacuated their homes due to the hurricane; 78.4% reported living in an environment affected by mold, flood, roof, glass, or storm damage at the time of survey administration.

There were no differences ($p > .05$) between children with and without pre-existing conditions with respect to person completing the survey, gender, race, ethnicity, facility, immunization status (up to date *vs.* not, as well as having missed an immunization); whether or not they evacuated; or the presence of roof, glass, or storm damage at the current residence. However, children with and without pre-existing chronic conditions differed from one another in several aspects. Children with chronic conditions sought care more often for new health problems than did children without chronic conditions. They were also more likely to visit the clinic for secondary health problems rather than their underlying chronic condition (43.5%). The chronic conditions *per se* were less often the reason for doctor's visits during the first months after the hurricane/evacuation (16.2%, $p < .001$). Children with pre-existing chronic conditions were also more likely to take medication or inhalers to control asthma than those without chronic health conditions (37.4% *vs.* 3.9%, $p < .001$), to have their asthma worsen (16.3% *vs.* 1.9%, $p < 0.001$), to have missed a doctor's visit (49.2% *vs.* 39.8%, $p < .01$), or to have run out of medications (33.9% *vs.* 7.9%, $p < .001$) since the hurricane or evacuation. Children with chronic conditions were more likely to live in a home with flood damage (19.7% *vs.* 11.3%, $p < .05$) or mold (23.6% *vs.* 15.8%, $p < .05$) after their return to post-Katrina New Orleans. While nearly half (43.9%) of the participants had experienced one or more disruptions in medical care (missed medications or doctor's visits, not being up to date on immunizations or having missed at least one immunization), children with pre-existing conditions were more likely than those without to have experienced at least one disruption in care (58.4% *vs.* 38.3%, $p < .001$). Although older children were more

Table 1.**CHARACTERISTICS OF PEDIATRIC PATIENTS (N=531)**

	n	% ^a
Gender		
Male	268	50.5
Female	263	49.5
Race		
Caucasian/White	227	42.8
African American/Black	215	40.5
Other	89	16.7
Age		
<1 year	69	13.0
1 to <5 years	179	33.7
5 to <13 years	176	33.2
13 to 24 years	107	20.2
Health care facility		
Children's Hospital New Orleans	387	72.9
Ochsner for Children	88	16.6
Tulane Hospital for Children	27	5.1
Other facilities	29	5.5
Clinic/ER visit purpose		
For a new health problem	250	47.1
For a physical/check-up or well-child visit	77	14.5
For a problem that existed before hurricane	150	28.3
Other	54	10.2
Chronic conditions prior to Hurricane Katrina ^b	209	39.4
Diabetes	17	3.2
Asthma or other chronic lung disease	93	17.5
Used asthma medication or inhalers prior to Hurricane Katrina	107	20.2
Self-report: Worsened asthma since Hurricane Katrina	33	6.2
Allergies	65	12.2
HIV/AIDS or other immune disease	10	1.9
Heart disease or heart defect	11	2.1
ADHD	20	3.8
Depression	10	1.9
Other mental health or behavioral disorder	19	3.6
Seizure disorder	15	2.8
Other conditions	50	9.4
Missed physician visit due to hurricane	182	41.1
Ran out of medications since the hurricane	84	19.7
Missed immunizations	37	8.4

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Table 1. (continued)

	n	% ^a
Currently up to date on immunizations	436	92.4
Hurricane-related experiences		
Evacuated from home due to hurricane	430	81.0
Became dehydrated or experienced heat exhaustion	17	3.9
Living environment (at the time of survey completion)		
with one or more adverse conditions:	424	78.4
Flood damage	73	14.0
Mold	99	18.9
Roof, glass, or storm damage	252	48.0

^aPercentages may not add up to 100 due to rounding.

^bRespondents could indicate more than one condition. This proportion represents participants with one or more conditions. Proportions are of the total sample (N=531).

likely to have a pre-existing condition [mean 8.22 (sd 5.49) vs. 6.14 (5.63), $p < .001$], younger children were more likely to have developed new symptoms or diagnoses than older children and adolescents [mean 6.51 (sd 5.46) vs. 7.97 (6.03), $p < .001$].

Among children with pre-existing chronic conditions, all of the HIV-positive participants ($n=7$) and 90% of the children with pre-existing diagnoses of depression ($n=9$) experienced one or more disruption in care ($p < .05$). After adjusting for age, race, gender, and facility, children with prior conditions were significantly more likely to experience a disruption in care than were their counterparts (OR 2.62, 95% CI 1.78–3.87, $p < .001$). Of the 102 children who reported having asthma (either as a chronic or non-chronic condition), 80 (78.4%) reported that they required more asthma medication or inhalers during the first three months after the hurricane than pre-Katrina. Of these, 30 (39.5%) reported that their asthma had worsened since September 2005. Of the 379 children who did not need asthma medication or inhalers prior to the hurricane, 12 (3.2%) began using such medication since September 2005, and nearly 2% of these children reported a worsening of symptoms since that time.

Specific symptoms were evaluated to compare children with and without pre-existing chronic conditions with respect to their development of new symptoms following the hurricane. Unlike the previous question that inquired about “chronic conditions” prior to the hurricane, the symptom panel data were collected based on experience of symptoms provided to the respondent in lay language and not in association with named diagnoses or current medications (Table 2). Children with pre-existing conditions were significantly ($p < .05$) more likely to develop respiratory symptoms (asthma, shortness of breath, and difficulty breathing), headache, and blurred vision. Children without pre-existing conditions were significantly ($p < .05$) more likely to report having bloody diarrhea and household accidents. Irrespective of prior conditions, participants

Table 2.

SIGNIFICANT DIFFERENCES BETWEEN CHILDREN AND ADOLESCENTS WITH AND WITHOUT CHRONIC CONDITIONS IN THE DEVELOPMENT OF NEW SYMPTOMS FOLLOWING HURRICANE KATRINA (N = 531)

Symptom	Participants with pre-existing chronic conditions (n=209) %	Participants without pre-existing chronic conditions (n=260) %
Asthma***	12.4	1.5
Shortness of breath***	16.3	4.2
Difficulty breathing*	12.9	5.2
Headache*	8.6	3.5
Blurred vision*	2.87	.4
Bloody diarrhea*	.0	1.9
Household accidents*	.0	2.3

* $p < .05$, ** $p < .01$, *** $p < .001$.
No significant difference with respect to remainder of symptom panel, which includes all body systems.

were otherwise similar ($p > .95$), with nearly three-quarters (74.2%) of all children developing at least one new symptom.

There were significant differences between those with and without pre-existing conditions in the psychological reactions and frightening experiences of children (Table 3). Children with chronic conditions were more likely than those children without chronic conditions to exhibit negative psychological consequences of the hurricane, overall sadness and withdrawal, and behavioral changes. Responses to each question indicated significantly higher negative reaction on every question, ranging from a difference of 2.5% to 12.9% (all $p < .05$).

Discussion

This study suggests that following a natural disaster such as Hurricane Katrina, children and adolescents with pre-existing chronic conditions are significantly more likely to experience negative health outcomes than those without. Chronically ill children and adolescents experienced more disruption in care and developed more new symptoms than those without. Children with diseases (including diabetes, asthma, other chronic lung disease, allergies, HIV/AIDS, other immune disease, heart defect/disease, cystic fibrosis, mental retardation, ADHD, autism, depression, other mental health or behavior problems, seizure disorder, sickle cell disease, kidney failure/dialysis, or liver failure) prior to Hurricane Katrina were also significantly more likely than those without

Table 3.**POSITIVE RESPONSES TO STRESS QUESTIONS (N=531)**

	Children with pre-existing chronic conditions (n=209) %	Children without pre-existing chronic conditions (n=260) %
For the child^a:		
“Did a family member or friend get injured or killed?”**	12.3	4.0
“Did you/your child see people getting hurt or killed?”*	13.3	8.9
“Did you see any violence or looting?”*	15.6	8.5
“Do you get upset, afraid, or sad when something makes you think of the hurricane/flooding/evacuation?”*	24.9	15.8
“Do you have upsetting thoughts or pictures that come to your mind about what happened?”**	19.1	10.4
“Do you have difficulty falling asleep at night or find that you wake up in the middle of the night because of what happened?”*	13.4	7.3
“Do you often feel jumpy or nervous?”*	12.9	6.5
“Do you find it harder to concentrate or pay attention to things than you usually do?”**	16.3	7.3
“Do you often feel irritable or grouchy?”*	20.1	12.7
“Do you often feel sad, down, or depressed?”*	13.9	8.1
“Do you have less energy than usual?”*	13.4	7.8
“Do you find it harder to get your schoolwork done?”* (To those in school only.)	11.0	5.0
“Do you worry about something else bad happening to you/family/friends?”*	15.3	8.1
“Are you having a harder time getting along with family or friends?”**	10.1	3.5
“Have you used drugs or alcohol since the hurricane/flooding/evacuation?”*	2.9	.4

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Table 3. (continued)

	Children with pre-existing chronic conditions (n=209) %	Children without pre-existing chronic conditions (n=260) %
For the parent:		
“Has your child talked repeatedly about or asked questions about the hurricane/flooding/evacuation?”***	22.5	9.6
“Has your child been more quiet or withdrawn?”*	5.7	1.5
“Has your child’s play been about the hurricane/flooding/evacuation?”*	5.3	.8
“Do you have other concerns about your child since the hurricane/flooding/evacuation?”*	13.4	7.3
^a Agreement indicated as “much” or “most” during the last month, except for first three, which are yes/no. *p<.05, **p<.01, ***p<.001. No significant difference with respect to remainder of questions.		

them to experience negative reactions to hurricane-related stressors. These reactions included increased fear, depression, post-traumatic stress symptoms, and behavioral alteration.

This study has several limitations. Participants were selected *via* convenience rather than by means of a random sampling method, and these findings are unlikely to be representative of the general population in New Orleans, either before or after the storm. Because this survey was anonymous, it was not possible to evaluate medical records for actual status regarding chronic conditions or current medical or psychological states and measures of interest are entirely based on self-report. Due to the cross-sectional nature of the design, it is difficult to determine temporality of events.

Furthermore, given that individuals with chronic conditions generally seek care more frequently due to their underlying health conditions, we cannot draw direct conclusions from the present study about the extent to which the disaster led to adverse outcomes and/or care-seeking by children and adolescents with chronic conditions. To draw such conclusions, we would have had to compare children and adolescents with chronic conditions who had experienced the hurricane with such children and adolescents who had not. Given the vast geographical region affected by Hurricane Katrina and the lack of appropriate controls, this comparison is not possible. Instead, the conclusions that we draw concern differences after a disaster between children

with pre-existing conditions and children without such conditions, where both groups experienced the hurricane. While we might have expected differences between these two groups with respect to condition-related experiences such as taking asthma medication, having asthma worsen, or having negative psychological consequences, we believe that the narrow time frame of the study (the first four months after the hurricane and evacuation) makes it unlikely that the observed changes were due to natural progression of chronic illness alone. It is also important to have established that children and adolescents with pre-existing chronic conditions were more likely than those without to miss a visit, to run out of medications, to live with flood damage or mold, and to experience disruption in care.

Additionally, given that individuals with chronic conditions generally seek care more frequently due to their conditions, there may be a bias towards inclusion of participants with chronic conditions. However, just over a third of the sample fell into this category, suggesting that the circularity of exposure and disruption of care may not bias these findings. The prevalence and severity of some chronic diseases such as HIV/AIDS and asthma have been linked to disparities in socioeconomic status,^{25–28} which may coincide with stress during times of natural disaster and displacement.^{21–24} Thus, those with chronic health conditions may be exposed to more stressful situations than their counterparts. Several studies suggest, however, that families with the least resources and social status were the last to evacuate, but also the least likely to have returned to New Orleans within the first months after the storm;^{29–32} such participants would therefore have been less likely to have been sampled in this study. Finally, the survey was developed following the hurricane, and similar measures are not available to estimate the pre-disaster differences. It may be that these findings are attributable in part to the chronic conditions themselves and not the interaction with the hurricane/evacuation. Future studies will be in a superior position to address this important research question.

This study has several strengths. It is one of the first to evaluate pediatric health outcomes following one of the largest natural disasters to hit the U.S., and to investigate the important role of pre-existing conditions in the care of children and adolescents. The anonymous nature of the study increases the likelihood of candor in response. The multi-faceted nature of the questionnaire allows investigation into a variety of exposures and outcomes. This analysis included data collected through December 2005; as more data become available to describe phenomena longitudinally, the question of whether the discrepancies between children and adolescents with and without chronic conditions attenuate will be examined.

This study suggests that children and adolescents with chronic conditions are at increased risk of adverse outcomes following natural disasters such as Hurricane Katrina. Providers may be able to reduce the negative effects on this population by developing condition-specific continuity of care mechanisms.^{33,34} Preparedness measures (such as evacuation medication packs, immunization registries that are readily transferable to other locations, and paperless medical records) may have helped to limit negative health outcomes at the time of simultaneous displacement of chronically ill patients, their families, and their regular health care providers. Clearly defined disaster preparedness plans for children and adolescents with chronic conditions may be able to

reduce disruptions of care during disaster. Reductions in disruptions of care may also help reduce stress experienced by children and adolescents, resulting in improvements in health outcomes.

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