

# Exposure to Hurricane Katrina, Post-traumatic Stress Disorder and Birth Outcomes

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**ABSTRACT:** *Background:* Little is known about the effects of natural disasters on pregnancy outcomes. We studied mental health and birth outcomes among women exposed to Hurricane Katrina. *Methods:* We collected data prospectively from a cohort of 301 women from New Orleans and Baton Rouge. Pregnant women were interviewed during pregnancy about their experiences during the hurricane, and whether they had experienced symptoms of post-traumatic stress disorder (PTSD) and/or depression. High hurricane exposure was defined as having 3 or more of the 8 severe hurricane experiences, such as feeling that one's life was in danger, walking through floodwaters, or having a loved one die. *Results:* The frequency of low birth weight was higher in women with high hurricane exposure (14.0%) than women without high hurricane exposure (4.7%), with an adjusted odds ratio (aOR): 3.3; 95% confidence interval (CI): 1.13–9.89;  $P < 0.01$ . The frequency of preterm birth was higher in women with high hurricane

exposure (14.0%) than women without high hurricane exposure (6.3%), with aOR: 2.3; 95% CI: 0.82–6.38;  $P > 0.05$ . There were no significant differences in the frequency of low birth weight or preterm birth between women with PTSD or depression and women without PTSD or depression ( $P > 0.05$ ). *Conclusions:* Women who had high hurricane exposure were at an increased risk of having low birth weight infants. Rather than a general exposure to disaster, exposure to specific severe disaster events and the intensity of the disaster experience may be better predictors of poor pregnancy outcomes. To prevent poor pregnancy outcomes during and after disasters, future disaster preparedness may need to include the planning of earlier evacuation of pregnant women to minimize their exposure to severe disaster events. **KEY INDEXING TERMS:** Depression; Disaster; Low birth weight; Post-traumatic stress disorder; Pregnancy. [*Am J Med Sci* 2008;336(2):111–115.]

**H**urricane Katrina, which made landfall on August 29, 2005 along the central Gulf Coast, has been described as “the worst catastrophe, or set of catastrophes” in the country's history, referring to

the hurricane itself as well as the flooding of New Orleans. Disasters and their aftermath are sources of enormous psychological stress and are likely to disrupt factors that are important to a healthy pregnancy, such as prenatal care, social support, and material resources. The experiences of pregnant women may influence not only their own health but also that of their unborn children, but little is known about the effects of disaster on pregnancy outcomes.<sup>1,2</sup> The objective of this study was to examine the effects of exposure to Hurricane Katrina on mental health and pregnancy outcomes. The findings from this study could be used for health care providers to identify women who are at higher risk of poor pregnancy outcomes, to improve disaster planning to assist a range of pregnant women, and to improve the outcome of pregnancy during and after disasters.

## Methods

We conducted a prospective cohort study at the prenatal care clinics at Tulane-Lakeside Hospital in New Orleans and Woman's Hospital in Baton Rouge (about 120 km away from New Orleans and less exposed to Hurricane Katrina) between January 2006 and June 2007. Two hundred twenty women from New Orleans and

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## Hurricane and Pregnancy Outcome

81 women from Baton Rouge who were pregnant during Hurricane Katrina or became pregnant immediately after the hurricane were recruited. Inclusion criteria were speaking English, planning to deliver at the study hospitals, being over 18 years old (for New Orleans), living in the area before the storm, and (for Baton Rouge) not having an extensive experience of the hurricane (evacuating or having a relative die). The women were interviewed about their hurricane experience and their psychological response, and potential confounding factors. These included demographics, socioeconomic status, tobacco and alcohol use, and reproductive and medical history. Women were followed until their delivery and their medical records were reviewed for the outcome of the pregnancy. This study was approved by the Institutional Review Boards of Tulane University and the participating hospitals.

The exposures of this study are high hurricane experience, PTSD, and depression. The hurricane experience questions were adapted from a questionnaire used in the Social and Cultural Dynamics of Disaster Recovery study after Hurricane Andrew.<sup>3,4</sup> High hurricane exposure was defined as having 3 or more severe experiences of the following events: feeling that one's life was in danger, experiencing illness or injury to self or a family member, walking through floodwaters, significant home damage, not having electricity for more than 1 week, having someone close die, or seeing someone die. Symptoms of PTSD were assessed with the validated Post-traumatic Stress Checklist—Civilian Version. This scale is a commonly used, brief 17-item inventory of PTSD-like symptoms, with response alternatives ranging from 1 (not at all) to 5 (extremely).<sup>5</sup> This scale performs particularly well when PTSD relative to a specific event is being assessed, as is the case in this study.<sup>6</sup> In accord with previous studies, a cutoff value of 50 was used to define PTSD in the present study. Maternal depression was assessed by using the Edinburgh Depression Scale.<sup>7</sup> Edinburgh Depression Scale has 10 items (questions). Each item is scored on a four-point scale (from 0 to 3), with minimum and maximum overall scores ranging 0 to 30. A cutoff value of 12 was used to define depression in the present study.

Outcome variables of this study include low birth weight (birth weight <2500 g) and preterm birth (gestational age <37 weeks). The gestational age was estimated based on the dates of last menstrual period, as well as early ultrasound when available.

$\chi^2$  tests were used to examine differences in proportions, and multiple logistic regression was used to adjust for the effects of confounding variables. The adjusted odds ratios (aORs) and their 95% confidence intervals (CIs) were derived from the coefficients of the logistic models and their standard errors. Data were analyzed using SPSS 15.0 for Windows (SPSS, Chicago, IL).

### Results

Table 1 presents the characteristics of the study population. After excluding missing data, 7.2% were 18- to 19-years old and 19.5% were  $\geq 35$  years old; 43.8% were non-Hispanic white and 41.6% were non-Hispanic black; 45.5% were primiparous. Of the multiparous women, 5.3% had prior history of low birth weight infants. The rates of PTSD and depression were 4.4% and 14.4%. The rates of low birth weight and preterm birth were 9.7% and 9.7%.

#### *Hurricane Experience and Birth Outcome*

A majority of the study population was exposed to 1 or more severe hurricane experiences (Figure 1), including feeling that one's life was in danger (34.9%), experiencing illness or injury to self (10.5%) or a family member (19.2%), walking through floodwaters (7.0%), severe home damage (50.9%), not having electricity for more than 1 week (60.3%),

**Table 1.** The Characteristics of the Study Population

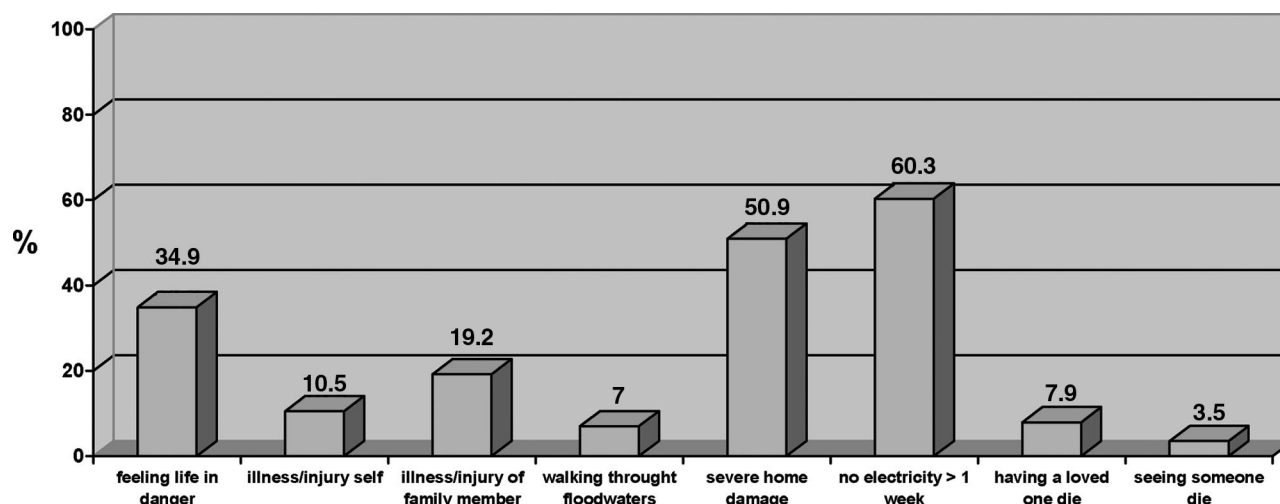
Characteristics <sup>a</sup>	No (%)
City	
New Orleans (Tulane-Lakeside Hospital)	220 (73)
Baton Rouge (Woman's Hospital)	81 (27)
Maternal age (yrs)	
18–19	20 (7.2)
20–34	203 (73.3)
$\geq 35$	54 (19.5)
Parity	
Primiparous	125 (45.5)
Multiparous	150 (54.5)
Family income	
<\$20,000	60 (24.9)
\$20,000–\$60,000	94 (39.0)
>\$60,000	87 (36.1)
Race	
White	96 (43.8)
Black	91 (41.6)
Other	32 (14.6)
History of low birth weight	
Yes	13 (5.3)
No	232 (94.7)
PTSD	
Yes	13 (4.4)
No	285 (95.6)
Depression	
Yes	43 (14.4)
No	255 (85.6)
Low birth weight	
Yes	29 (9.7)
No	269 (90.3)
Preterm birth	
Yes	29 (9.7)
No	270 (90.3)

<sup>a</sup> Excluding missing data.

having a loved one die (7.9%), or seeing someone die (3.5%). Frequency of women who had no, 1, 2, 3, and 4 or more severe hurricane experiences were 13.6%, 22.3%, 24.8%, 19.5%, and 22.7%, respectively. High hurricane exposure was associated with a more than three-fold increased risk of having low birth weight infants, even after adjustment for confounding variables (Table 2: adjusted odds ratio (aOR): 3.3; 95% confidence interval (CI): 1.13–9.89;  $P < 0.01$ ). High hurricane exposure was also associated with a more than two-fold increased risk of having preterm birth infants (Table 2: aOR: 2.3; 95% CI: 0.82–6.38;  $P > 0.05$ ). There was a trend toward increased rates of low birth weight and preterm birth with an increasing number of severe hurricane experiences or events (Table 2). Compared with women who had no or 1 severe hurricane experience, the aORs and 95% CIs of low birth weight for women who had 2, 3, and 4 or more severe hurricane experiences were 2.1 (0.39–11.5), 4.0 (0.87–18.4), and 5.5 (1.19–25.4), respectively.

#### *PTSD and Depression and Birth Outcomes*

The frequency of low birth weight was higher in women with PTSD (23.1%) and with depression



**Figure 1.** Frequency of the severe experience of the hurricane among pregnant women.

(11.6%) than that in women without PTSD (9.1%) and without depression (9.4%). The adjusted ORs and 95% CIs of low birth weight for women with PTSD and depression were 3.1 (0.79–12.6) and 1.3 (0.42–3.79). PTSD and depression were associated with a statistically nonsignificant increased risk of low birth weight. However, the frequency of preterm birth was lower in women with PTSD (7.7%) and with depression (7.0%) than that in women without PTSD (9.8%) and without depression (10.2%). The adjusted ORs and 95% CIs of preterm birth for women with PTSD and depression were 0.8 (0.10–6.39) and 0.7 (0.19–2.56). PTSD and depression

were associated with a statistically nonsignificant decreased risk of preterm birth.

### Discussion

Hurricane Katrina affected almost everyone in the New Orleans area, through the stress of relocation, uncertainty, discontinuity in medical care, social network disruption, and loss of lives, jobs, and property. Although the exposure to such a devastating disaster as Hurricane Katrina could potentially have substantial effects, we do not see a significantly increased rate overall of low birth weight

**Table 2.** Hurricane Katrina Experience, PTSD and Birth Outcomes

Variables <sup>a</sup>	%	Low Birth Weight		%	Preterm Birth	
		OR (95% CI)	aOR (95% CI) <sup>b</sup>		OR (95% CI)	aOR (95% CI) <sup>b</sup>
High hurricane exposure ( $\geq 3$ events)						
No (n = 127)	4.7	Referent	Referent	6.3	Referent	Referent
Yes (n = 93)	14.0	3.3 (1.20–8.98)	3.3 (1.13–9.89)	14.0	2.4 (1.00–6.10)	2.3 (0.82–6.38)
No. hurricane experiences/events						
0 (n = 30)				6.7	Referent	Referent
1 (n = 49)	3.8 <sup>c</sup>	Referent <sup>c</sup>	Referent <sup>c</sup>	4.1	0.6 (0.08–4.47)	0.5 (0.07–4.44)
2 (n = 48)	6.3	1.7 (0.33–8.73)	2.1 (0.39–11.5)	8.3	1.3 (0.22–7.41)	1.4 (0.24–9.28)
3 (n = 43)	14.0	4.1 (0.97–17.3)	4.0 (0.87–18.4)	11.6	1.8 (0.33–10.2)	1.7 (0.26–10.3)
$\geq 4$ (n = 50)	14.0	4.1 (1.01–16.8)	5.5 (1.19–25.4)	16.0	2.7 (0.53–13.5)	2.9 (0.49–17.1)
PTSD						
No (n = 285)	9.1	Referent	Referent	9.8	Referent	Referent
Yes (n = 13)	23.1	2.9 (0.77–11.5)	3.1 (0.79–12.6)	7.7	0.8 (0.10–6.10)	0.8 (0.10–6.39)
Depression						
No (n = 255)	9.4	Referent	Referent	10.2	Referent	Referent
Yes (n = 43)	11.6	1.3 (0.46–3.52)	1.3 (0.42–3.79)	7.0	0.7 (0.19–2.29)	0.7 (0.19–2.56)

<sup>a</sup> Excluding missing data.

<sup>b</sup> aOR of logistic regression adjusted for maternal age, race, parity, education, marital status, smoking, alcohol consumption, family income, and history of low birth weight.

<sup>c</sup> Because of no cases of low birth weight in women who had no severe experience of the hurricane, this group of women were combined into the group of women with one severe experience of the hurricane.

(9.7%) or preterm birth (9.7%) in our study sample. However, our study suggested that pregnant women who had severe hurricane experiences were at higher risk of delivering low birth weight and preterm birth infants. In particular, women who experienced 3 or more severe hurricane events were at a markedly increased risk of delivering low birth weight and preterm infants.

There are a few previous studies reporting the effects of natural and man-made disasters such as earthquakes and the September 11 attacks on the World Trade Center on adverse pregnancy outcomes. An increase in very low birthweight infants was noted immediately after September 11 in New York City, as were delayed increases in some types of preterm and LBW.<sup>8</sup> An increased risk of intrauterine growth retardation was reported among women exposed to the environmental effects of September 11, though other birth outcomes did not differ.<sup>9</sup> Chang et al reported that spouse casualty after an earthquake predicted low birth weight, and the overall sample had 7.8% low birth weight, high for Taiwan.<sup>10</sup> Civil war raised the risk of premature births, stillbirths, and abortions in the Congo, though the hardships of collecting data in that situation make it difficult to interpret those results.<sup>11</sup> On the other hand, other studies in wartime found that mothers often do relatively well in overall adverse conditions.<sup>12</sup> During a disaster period, pregnant women may have a better access to care through relief programs and may receive added support from family and society.

Findings from a few previous studies on the effects of PTSD on pregnancy outcomes are inconsistent or even controversial. One study found that women near the World Trade Center who reported more PTSD delivered infants with reduced head circumference but longer gestations.<sup>13</sup> In nondisaster settings, one study reported that PTSD was associated with an increased risk of preterm birth (adjusted OR: 2.82; 95% CI: 0.95–8.38;  $P > 0.05$ ) but a decreased risk of low birth weight (adjusted OR: 0.83, 95% CI: 0.19–3.66;  $P > 0.05$ ).<sup>14</sup> However, our study found that PTSD and depression were associated with a slightly increased risk of low birth weight but a reduced risk of preterm birth. Clearly, although psychosocial stress and trauma may be significant risk factors, not all women with PTSD and depression have poor pregnancy outcomes. Apart from the nature and intensity of the disaster experience, social and family support, buffers, the timing of disaster exposure during gestation, and other risk factors, such as race and biomedical factors, all may mediate the effects of PTSD and depression on pregnancy outcomes.<sup>15–17</sup>

The results of this study should be interpreted with the following limitations in mind. Most of the women in our study were in the early stages of pregnancy at Katrina or became pregnant in the 6

months after Katrina; results might be different in women who gave birth immediately after the storm. The sample size of the present study is relatively small. This may limit statistical power to detect statistical significance in the associations and increase the potential for observing discrepancies in the effects of mental health on birth outcomes. Pregnant women seeking prenatal care were recruited on a volunteer basis and those women who did not seek prenatal care or refused to participate in the study may be different from the women who agreed to participate, in terms of the hurricane experience, risk profiles, and pregnancy outcomes. We do not have data on the women who did not want to participate.

In summary, although the effects of PTSD and depression after a disaster on birth outcomes are yet to be determined, women who had high hurricane exposure are at an increased risk of having low birth weight and preterm infants. The present study highlights that, rather than a general exposure to disaster, exposure to specific severe disaster events and the intensity of the disaster experience may be better predictors of poor pregnancy outcomes. To reduce poor pregnancy outcomes during and after disasters, future disaster preparedness may include planning of earlier evacuation of pregnant women to safe locations to minimize their direct exposure to severe disaster events. Our data would also suggest, however, that disaster is unlikely to cause a major increase in pregnancy complications among the general, less exposed population.

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