Published in final edited form as:

Matern Child Health J. 2015 November ; 19(11): 2512–2522. doi:10.1007/s10995-015-1772-4.

Birth outcomes in a disaster recovery environment: New Orleans women after Katrina

Emily W. Harville, PhD¹, Gloria Giarratano, PhD², Jane Savage, PhD^{2,3}, Veronica Barcelona de Mendoza, MPH^{1,2}, and TrezMarie Zotkiewicz, MSN

¹ Department of Epidemiology, Tulane School of Public Health and Tropical Medicine, New Orleans, LA

² Department of Nursing, Louisiana State University Health Sciences Center, New Orleans, LA

³ Department of Nursing, Loyola University, New Orleans, LA

Abstract

Objectives—To examine how the recovery following Hurricane Katrina affected pregnancy outcomes.

Methods—308 New Orleans area pregnant women were interviewed 5-7 years after Hurricane Katrina about their exposure to the disaster (danger, damage, and injury); current disruption; and perceptions of recovery. Birthweight, gestational age, birth length, and head circumference were examined in linear models, and low birthweight (<2500 g) and preterm birth (<37 weeks) in logistic models, with adjustment for confounders.

Results—Associations were found between experiencing damage during Katrina and birthweight (adjusted beta for high exposure = -158 g) and between injury and gestational age (adjusted beta = -0.5 days). Of the indicators of recovery experience, most consistently associated with worsened birth outcomes was worry that another hurricane would hit the region (adjusted beta for birthweight: -112 g, p=0.08; gestational age: -3.2 days, p=0.02; birth length: -0.65 cm, p=0.06)

Conclusions—Natural disaster may have long-term effects on pregnancy outcomes. Alternately, women who are most vulnerable to disaster may be also vulnerable to poor pregnancy outcome.

Keywords

disaster; pregnancy; birthweight

INTRODUCTION

The effects of Hurricane Katrina continue to be felt in New Orleans, ten years later. The population of New Orleans in 2013 was at 78% of 2000 levels, with particularly sharp declines seen among African-Americans (1). Some parts of the city still feature destroyed buildings and roads. Housing rentals became more unaffordable, the poverty rate remains

Address for correspondence: Emily Harville, Associate professor, Department of Epidemiology, Tulane University School of Public Health and Tropical Medicine, 1440 Canal St., New Orleans, LA 70112-2715, Tel. 504-988-7327, Fax. 504-988-1568, harville@tulane.edu.

high (2), crime is a constant concern, and the number of blighted and abandoned houses and buildings rose sharply after the storm (3). In addition, less all-encompassing but still potentially traumatic disasters (such as Hurricanes Gustav and Isaac, and the Deepwater Horizon oil spill) have occurred in the time since Katrina. While post-traumatic stress disorder (PTSD) and psychological distress have declined among residents, they have not returned to pre-hurricane levels (4), and one study found a more persistent course of illness in Katrina-exposed populations than other disaster-exposed populations (5).

Disaster may cause worsened birth outcomes among exposed pregnant women, but the evidence is still mixed (review(6)). Negative effects on fetal growth and birthweight have been found in many studies, including after terrorist attacks and bombings, environmental disasters, and natural disasters, though counter-examples can be found (6). However, several large studies of terrorist attacks, hurricanes, and chemical disasters found no association with gestational age or preterm birth, although some smaller studies found increased risk (6). Similarly, Hurricane Katrina was associated with a higher risk of low birthweight and preterm birth in a smaller study (7), but no associations were seen in the larger analyses of vital records data (8, 9).

Conservation of Resources (COR) theory (10) proposes that loss of resources (that which people value) results in psychological distress. As originally conceptualized, resources fall into four categories: objects, personal characteristics (e.g., knowledge, self-esteem, skills), conditions (e.g., interpersonal relationships, employment, sense of community), and energies (e.g., credit, money, insurance) (10). All of these categories can be significantly impacted, over the long term, by disaster. The COR model has empirical support for short-term effects of disaster on mental health: studies conducted 2-7 months after disasters have found resource loss to be one of the strongest predictors of psychological distress (11-13). In a previous study of Hurricane Katrina, postpartum women interviewed 1-3 years after disaster indicated that loss of resources mediated the effects of hurricane exposure on depression (14). Studies of physical effects are less extensive, though Smith and Freedy (13) found that psychosocial resource loss mediated the effects of flood exposure on physical symptoms.

Additionally, disasters can lead to resource loss spirals, or the continued loss of resources (15), causing the effects of disaster to linger for years. Long-term socioeconomic decline and socioeconomic resource deficit were associated with cardiometabolic events and pain 4 years after Hurricane Katrina, even after the initial experience of the hurricane was taken into account (16). A study done 3 years after the Wenchuan earthquake found high levels of chronic disease and low quality of life (17). Loss of resources due to the Exxon Valdez oil spill was associated with depression, anxiety, and PTSD among fishers 6 years after the spill (18). Most long-term studies find that, while resilience and recovery are the most common psychological responses to disaster, a small proportion of the population will exhibit chronic or increasing mental health symptoms for even decades after the event (19).

We are aware of only one previous study that has examined the long-term effect of disaster on pregnancy. This study examined both New York after the September 11 attacks and Madrid after the train bombing, and found a long-term increase in infant mortality in New York, but no increase in low birthweight or preterm birth, and no long-term effects on low

birthweight, preterm birth, or infant mortality in Madrid (20). This study relied on vital records data, and so had no information about the individual experiences of the women either during or after the attacks. In this analysis, we examine how initial hurricane experience, continuing disruption, and resource deficit predict birth outcomes in a cohort of New Orleans pregnant women. We hypothesized that current disruption and negative perceptions of recovery would be associated with poor birth outcomes; that hurricane experience would be also associated with poor outcomes; and that current disruption and resource deficit would partly account for associations between hurricane experience and birth outcomes.

Methods

Population

Study participants were recruited from 7 clinical sites (prenatal clinics, childbirth classes, and Healthy Start classes) between 2010 and 2012 for a study of hurricane recovery, birth outcomes, and mental health. Women were eligible if they were 18 years or older, living in the greater New Orleans area, receiving regular prenatal care, and between 6 and 9 months pregnant. Since one of the study goals was to compare different models of prenatal care, women not receiving care were excluded. About 94% of Louisiana (93% of New Orleans) women receive prenatal care in the first or second trimester (21). Given the relatively small proportion of women not receiving any (as opposed to late, who were eligible for this study) prenatal care and the fact that including women not receiving prenatal care would probably require a separate study, the omission of women who did not receive prenatal care was not considered a major source of bias. On recruiting days, all women at the sites were approached and asked to participate. Women also contacted the study after seeing recruitment flyers at the sites. Four hundred and two women participated; medical records could be located for 308 of them. Reasons for records being unavailable included women not delivering at the hospital that they indicated that they would deliver at, moving from the area, and changing their names; these could not be distinguished. There were no statistical differences between women who could be matched to medical records and women who could not with respect to age, race, education, marital status, income, parity, or smoking. Eight women had twin or triplet pregnancies, leaving 300 for analysis. Two hundred and ninety-seven had complete data on at least one exposure and outcome.

Measures

Exposures—Hurricane experience was measured with 11 questions, based on a study of Hurricane Andrew by Kaniasty and Norris (22). This scale was associated with poorer mental health and birth outcomes in previous studies (23, 24). Factor analysis was conducted to group the questions for similar aspects of exposure, creating three categories: damage, perceived/experienced danger, and injury, largely consistent with previous work (25). Scores in each category were summed and categories merged to create sufficient power. Damage was created from some or more “damage to house”, “house flooded”, some or greater “impact of hurricane”, and some or greater “total impact on other people”, and categorized as 0=low experience, 1-3=medium, and 4=high. Danger was created from “felt life in danger”, “walked in floodwater”, and “saw someone die”, and categorized as 0=low,

1=medium, and 2-3=high. Injury was created from “experienced illness/injury”, “someone in household experienced illness/injury”, “someone near died”, and “someone else important experienced illness/injury” and categorized in the same way as danger.

Women were also asked to rate their perceptions of life in the city and expectations for the city’s future. The majority of the question wordings were taken from the Kaiser Foundation survey “Giving Voice to the People of New Orleans”, a general survey of life in post-Katrina New Orleans (26). Questions touched on personal recovery from Katrina (somewhat/very disrupted vs. largely or completely back to normal) and satisfaction with life in one’s parish (very/somewhat dissatisfied vs. somewhat or very satisfied). Women were also asked about progress in a series of areas (crime, health care, services, rebuilding neighborhoods, schools, streets, levees); these were summed and categorized to a three-level variables for perception of progress in recovery. Several questions asked about the level of worry the participant had about their and the city’s future in various domains (hurricanes, income, health care, pollution, levees, housing); these were dichotomized as very much/somewhat vs. not too much/not at all. Overall economic resource deficit was created as the sum of worry scores about not having sufficient income, accessing health care, and having a place to live, and dichotomized as “high” if at least two of these were reported as “very worried”. Factor analysis was performed to reduce the number of items; satisfaction with life in the parish and progress in the city’s recovery were thus combined to a single 3-level variable.

Mental health was assessed through the indications of depression, post-traumatic stress disorder (PTSD), and pregnancy-related anxiety. The Edinburgh Postnatal Depression Index (EDSI) was used to measure depression (27). Although initially designed for postnatal depression, the measure has been validated for pregnant women (28) and is useful for this population because it avoids symptoms common to both depression and pregnancy, i.e., changes in sleep and appetite. A cutoff value of 12 (29) was used to indicate likely depression. The PCL is the post-traumatic checklist, which asks about symptoms (PTSD checklist)(30). Ventureyra reported a Cronbach’s alpha of 0.86 for the PCL(31). PTSD symptoms were dichotomized at scores greater than 50. Pregnancy-specific anxiety was assessed using the Revised Prenatal Distress Questionnaire (32). This 17-item instrument explores health concerns related to health of mother and baby, symptoms of pregnancy, medical care and financial issues related to pregnancy. Responses were scored on a Likert scale (0=not at all, 1=somewhat, 2=very much), and dichotomized to >17 indicating the presence of prenatal anxiety.

Outcomes—All outcome measures were abstracted from medical records. Birthweight, length, head circumference, and gestational age were examined as continuous outcomes. Low birthweight (birthweight <2500 g) and preterm birth (<37 completed weeks of gestation) were examined as secondary analyses.

Confounders—Age, race, education, marital status, smoking, and income were included in models as confounders because of their associations with the exposures in this dataset and known associations with the outcome. Unless otherwise specified, variables listed were modeled in the form listed in table 1.

Effect modifiers—Because of concerns that the results might not apply to women who moved to New Orleans after Katrina, or that they would vary by length of time displaced, we also examined an interaction with these measures. Women were asked whether they lived in New Orleans prior to Katrina (yes/no) and how long after Katrina they had returned/moved to the New Orleans area (categorized as <1, 1-2, 3-4, 5+ years).

Analysis

Variables were examined for distributions and frequencies. Bivariate and multivariable associations were examined using linear (for continuous) and logistic (for dichotomous) models. Initial analysis included only predictor variables, and multivariable analysis included the confounders above. The next planned analysis included possible mediators of effects of hurricane experience – disruption, resource deficit, and mental health. The results indicated that resource deficit was the most likely mediator, so results were analyzed with overall resource deficit as a covariate. The interaction between exposure measures and living in New Orleans prior to the storm, as well as timing of return to New Orleans, was examined using a product term. Missing data for covariates were multiply imputed using PROC MI and MIANALYZE in SAS 9.3 (33); most commonly missing was income (n=18; 6%).

The study was approved by the Institutional Review Boards of LSU and Tulane University, and all participants provided written informed consent.

RESULTS

The study population was largely in their 20s, majority African-American, unmarried, and low-income (table 1). Incidence of low birthweight and preterm birth was 6-7% (of the group with these complications, 39% were low birthweight only, 39% preterm birth only, and 23% both); median birthweight was 3250 g and median gestational age was 39.2 weeks. There was a large range of exposure to Katrina, with 23% reporting no serious exposure to the hurricane and 12% reporting 8 or more serious experiences of the hurricane. Similarly, 36% reported their lives were completely back to normal, while 10% reported their lives were still much disrupted. There were demographic differences in reported exposure to the hurricane and current life disruption (Table S1); in particular, African-American women reported more current disruption, more initial hurricane exposure, and more worries about resources.

First, we examined the women's current living situation and concerns (table 2). Most consistently associated with worsened birth outcomes was worry that another hurricane would hit the region (adjusted beta for birthweight: -112 g, p=0.08; gestational age: -3.2 days, p=0.02; birth length: -0.65 cm, p=0.06).

Mental health was not strongly associated with any outcome (Table 3). Depression was not associated with birthweight, gestational age or birth length, and was associated with head circumference only in bivariate association (unadjusted beta, -0.52 cm, p=0.01; adjusted beta -0.26, p=0.26). For PTSD, the associations were in the direction of PTSD being associated with reduced gestational age (adjusted beta -2.85 days, p=0.17) and higher

preterm birth rate (adjusted OR 3.61, 0.93-14.03; table S2). All relationships between pregnancy-related anxiety and the outcomes were small and/or imprecise.

Hurricane experience was associated with some complications (table 4). In bivariate analysis, more severe hurricane experience was associated with lower birthweight (danger, damage, injury), gestational age (injury), birth length (danger, injury), and head circumference (danger, damage, injury). After adjustment for confounders, associations remained between damage and birthweight (adjusted beta for high exposure = -158 g) and between injury and gestational age (adjusted beta = -5.0 days). The major change in effect estimate and statistical strength for associations with other aspects of the hurricane was from adjusting for standard confounders, rather than resource deficit. There was an increased risk for preterm birth with injury (aOR 5.22, 1.60-17.06, p for trend <0.01; table S3), and perhaps with damage and danger.

Women who lived in New Orleans prior to Katrina were reported higher levels of current disruption, dissatisfaction with the parish and recovery, depression, and PTSD compared to those who did not. They also reported higher exposure to the hurricane, although about 10% of the women who had not lived in the city reported some degree of exposure, most likely due to living in other affected areas or due to effects on family and friends. Women who returned earlier were less likely to report that their life was still disrupted. There were no other significant differences. Living in New Orleans prior to the storm and time of return did not directly predict any outcome, nor were there any consistent interactions with any of the disruption, worry, mental health, or hurricane experience variables. All aspects of disruption and hurricane experience predicted all mental health outcomes, with the exception of worry about future hurricanes, which was unassociated with either depression, PTSD, or pregnancy-related anxiety.

DISCUSSION

This study is one of the few to consider long-term effects of disaster on pregnant women. Our hypotheses (current disruption, negative perceptions of recovery, and hurricane experience would be associated with poor outcomes) were only partially borne out. In this analysis of pregnancy and birth outcomes 7 years after Hurricane Katrina, some measures of experience of the hurricane were still associated with reduced gestational age and neonatal growth measurements, as was ongoing worry about future hurricanes. There were fewer direct associations with current disruption or perceptions of recovery, making them unlikely mediators. To our knowledge, only one previous study that has examined the long-term effect of disaster on pregnancy, finding mixed results on the long-term effects of the September 11th attacks and Madrid train bombings (20). This study is generally consistent with previous research finding that disaster affects infant growth and gestational age (6), although our results were not always robust to adjustment for confounders. Previous research has tended to find stronger associations with growth than gestational age. A few other outcomes have been examined in Katrina-exposed populations, and initial exposure severity was most strongly associated with slow recovery from PTSD after Katrina in one study, consistent with ours (5).

We also hypothesized that, consistent with the COR theory and some other studies (16), that resource deficit would partly account for associations between hurricane experience and birth outcomes. Our results, though, would suggest that the initial hurricane experience and ongoing hurricane-related worry were most important in predicting outcomes, as the results were not consistent with substantial mediation by current socioeconomic resource deficit.

The long-term effect of disasters on birth outcomes could work through several mechanisms. The difficult circumstances do not disappear in the months following the storm. Surrounding circumstances may lead to increases in risk factors for adverse pregnancy outcomes – for instance, lack of access or concern for contraception could lead to more unplanned pregnancies or sexually transmitted infections (34, 35). Pregnant women with PTSD are at increased risk of adverse birth outcomes (36), health behaviors, and health care (37). Disparities in food access continue to exist and worsened after the storm (38) which combined with the tendency for mothers to put their needs behind those of their children during disasters, could lead to nutritional deficits (39). An excess of household breakup was documented after Katrina (40), and disaster exposure was associated with partner violence in at least one study (41), which could lead to reduced economic and social support. Finally, consistent with the associations seen with continued worry about the hurricanes, stress and anxiety have frequently been associated with adverse birth outcomes (42). The associations with worry about hurricanes are perhaps of interest because they were not strongly correlated with any of the sociodemographic variables, and may therefore be less susceptible to residual confounding.

This is one of the first studies to examine the long-term effects of disaster on pregnant women. Limitations of the study include a fairly small sample size (any positive associations could be statistical artifacts) and the self-report of hurricane experience which occurred up to 7 years prior. Many of the associations were substantially reduced by adjustment for confounding, indicating that the associations that remain may be the result of residual confounding. The study is limited to pregnant women who were receiving some form of prenatal care, and who had returned to the city. However, only a small proportion of women do not receive any prenatal care (21). Rates of complications were lower in our sample than the parish averages, which may reflect the fact that the women were receiving prenatal care to some degree. All women in the sample lived in the New Orleans area, meaning they were at least somewhat exposed to the post-disaster environment; still, the range of exposure to Katrina within the sample was substantial. The population shifted after Katrina, and those who have relocated might be at higher risk (still separated from social networks and hometown) or decreased risk (not exposed to daily reminders of the storm, living in more functional cities).

This study could indicate that major disasters can have long-term effects on the reproductive health of vulnerable populations. Alternately, they could indicate that women who are most vulnerable to severe experiences of natural disaster are also vulnerable to poor pregnancy outcomes. Either interpretation could be of importance to those planning for and supporting women during disaster recovery. Future studies should continue to monitor the perceptions and outcomes of disaster during the challenging recovery phase.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

This study was supported by NIH grant R03 NR012052 to GG.

References

1. U.S. Census Bureau: State and County QuickFacts. New Orleans (city), Louisiana: 2015. <http://quickfacts.census.gov/qfd/states/22/2255000.html>. Accessed March 20, 2015
2. Plyer, A. Facts for Features: Hurricane Katrina Recovery. Greater New Orleans Community DataCenter; New Orleans, LA: 2013. https://gnocdc.s3.amazonaws.com/reports/GNOCDC_HurricaneKatrinaRecovery.pdf. Accessed July 22 2013
3. New Orleans Residents Say Recovery Is Making Progress, But Many Believe The Gulf Oil Spill Will Be More Damaging Than Katrina. The Henry J. Kaiser Family Foundation; Menlo Park, CA: 2010. <http://kff.org/disparities-policy/press-release/new-orleans-residents-say-recovery-is-making-progress-but-many-believe-the-gulf-oil-spill-will-be-more-damaging-than-katrina/>
4. Paxson C, Fussell E, Rhodes J, et al. Five years later: Recovery from post-traumatic stress and psychological distress among low-income mothers affected by Hurricane Katrina. *Soc Sci Med*. 2012; 74:150–7. [PubMed: 22137245]
5. McLaughlin KA, Berglund P, Gruber MJ, et al. Recovery from PTSD following Hurricane Katrina. *Depress Anxiety*. 2011; 28(6):439–46. doi:10.1002/da.20790. [PubMed: 21308887]
6. Harville E, Xiong X, Buekens P. Disasters and perinatal health: a systematic review. *Obstet Gynecol Surv*. 2010; 65(11):713–28. doi:10.1097/OGX.0b013e31820eddb. [PubMed: 21375788]
7. Xiong X, Harville EW, Mattison DR, et al. Exposure to Hurricane Katrina, post-traumatic stress disorder and birth outcomes. *Am J Med Sci*. 2008; 336(2):111–5. [PubMed: 18703903]
8. Harville EW, Tran T, Xiong X, et al. 2010; 4(Suppl 1):S39–45. doi:10.1001/dmp.2010.15.
9. Hamilton BE, Sutton PD, Mathews TJ, et al. The effect of Hurricane Katrina: Births in the U. S. Gulf Coast Region, before and after the storm. *National Vital Statistics Reports*. 2009; 58(2)
10. Hobfoll SE. Conservation of resources. A new attempt at conceptualizing stress. *Am Psychol*. 1989; 44(3):513–24. [PubMed: 2648906]
11. Freedy JR, Shaw DL, Jarrell MP, et al. Towards an understanding of the psychological impact of natural disasters: An application of the conservation resources stress model. *J Trauma Stress*. 1992; 5(3):441–54.
12. Freedy JR, Saladin ME, Kilpatrick DG, et al. Understanding acute psychological distress following natural disaster. *J Trauma Stress*. 1994; 7(2):257–73. [PubMed: 8012746]
13. Smith BW, Freedy JR. Psychosocial resource loss as a mediator of the effects of flood exposure on psychological distress and physical symptoms. *J Trauma Stress*. 2000; 13(2):349–57. [PubMed: 10838680]
14. Ehrlich M, Harville E, Xiong X, et al. Loss of resources and hurricane experience as predictors of postpartum depression among women in southern Louisiana. *J Womens Health (Larchmt)*. 2010; 19(5):877–84. doi:10.1089/jwh.2009.1693 [doi]. [PubMed: 20438305]
15. Sattler DN, Preston AJ, Kaiser CF, et al. Hurricane Georges: a cross-national study examining preparedness, resource loss, and psychological distress in the U.S. Virgin Islands, Puerto Rico, Dominican Republic, and the United States. *J Trauma Stress*. 2002; 15(5):339–50. [PubMed: 12392221]
16. Joseph NT, Matthews KA, Myers HF. Conceptualizing Health Consequences of Hurricane Katrina From the Perspective of Socioeconomic Status Decline. *Health Psychology*. 2013 doi:10.1037/a0031661.

17. Wen J, Shi YK, Li YP, et al. Quality of life, physical diseases, and psychological impairment among survivors 3 years after Wenchuan earthquake: a population based survey. *PLoS One*. 2012; 7(8):e43081. doi:10.1371/journal.pone.0043081. [PubMed: 22937014]
18. Arata CM, Picou JS, Johnson GD, et al. Coping with technological disaster: an application of the conservation of resources model to the Exxon Valdez oil spill. *J Trauma Stress*. 2000; 13(1):23–39. [PubMed: 10761172]
19. Holgersen KH, Klockner CA, Boe HJ, et al. Disaster survivors in their third decade: trajectories of initial stress responses and long-term course of mental health. *J Trauma Stress*. 2011; 24(3):334–41. doi:10.1002/jts.20636. [PubMed: 21594899]
20. Sherrieb K, Norris FH. Public health consequences of terrorism on maternal-child health in new york city and madrid. *J Urban Health*. 2013; 90(3):369–87. doi:10.1007/s11524-012-9769-4. [PubMed: 23070751]
21. March of Dimes Foundation. Peristats: Louisiana. 2014. <http://www.marchofdimes.com/Peristats/ViewTopic.aspx?reg=22&top=5&lev=0&slev=4>. Accessed March 20 2014
22. Norris FH, Perilla JL, Riad JK, et al. Stability and change in stress, resources, and psychological morbidity: who suffers and who recovers: Findings from Hurricane Andrew. *Anxiety Stress Coping*. 1999; 12:363–96. [PubMed: 21777067]
23. Harville EW, Xiong X, Pridjian G, et al. Postpartum mental health after Hurricane Katrina: A cohort study. *BMC Pregnancy Childbirth*. 2009; 9(1):21. [PubMed: 19505322]
24. Xiong X, Harville EW, Mattison DR, et al. Hurricane Katrina experience and the risk of post-traumatic stress disorder and depression among pregnant women. *Am J Disaster Med*. 2010; 5(3): 181–7. [PubMed: 20701175]
25. Harville EW, Xiong X, Smith BW, et al. Combined effects of Hurricane Katrina and Hurricane Gustav on the mental health of mothers of small children. *J Psychiatr Ment Health Nurs*. 2011; 18(4):288–96. doi:10.1111/j.1365-2850.2010.01658.x. [PubMed: 21418428]
26. KaiserFamilyFoundation. Giving Voice to the People of New Orleans: The Kaiser Post-Katrina Baseline Survey. Kaiser Family Foundation; Menlo Park: CA: 2007. <http://www.kff.org/kaiserpolls/pomr051007pkg.cfm> Accessed July 30, 2007
27. Murray D, Cox JL. Screening for depression during pregnancy with the Edinburgh depression scale. *J Reprod Infant Psychol*. 1990; 8:99–107.
28. Bergink V, Kooistra L, Lambregtse-van den Berg MP, et al. Validation of the Edinburgh Depression Scale during pregnancy. *J Psychosom Res*. 2011; 70(4):385–9. doi:10.1016/j.jpsychores.2010.07.008. [PubMed: 21414460]
29. Matthey S. Calculating clinically significant change in postnatal depression studies using the Edinburgh Postnatal Depression Scale. *Journal of Affective Disorders*. 2004; 78(3):269–72. [PubMed: 15013253]
30. Weathers, FW.; Litz, BT.; Herman, DS., et al., editors. The PTSD checklist (PCL): Reliability, validity, and diagnostic utility; 9th Annual Conference of the International Society of Traumatic Stress Studies; San Antonio, TX. 1993.
31. Ventureyra VA, Yao SN, Cottraux J, et al. The validation of the Posttraumatic Stress Disorder Checklist Scale in posttraumatic stress disorder and nonclinical subjects. *Psychother Psychosom*. 2002; 71(1):47–53. [PubMed: 11740168]
32. Yali AM, Lobel M. Coping and distress in pregnancy: an investigation of medically high risk women. *J Psychosom Obstet Gynaecol*. 1999; 20(1):39–52. [PubMed: 10212886]
33. Zhou XH, Eckert GJ, Tierney WM. Multiple imputation in public health research. *Stat Med*. 2001; 20(9-10):1541–9. [PubMed: 11343373]
34. Hapsari ED, Widyawati, Nisman WA, et al. Change in contraceptive methods following the Yogyakarta earthquake and its association with the prevalence of unplanned pregnancy. *Contraception*. 2009; 79(4):316–22. [PubMed: 19272502]
35. Kissinger P, Schmidt N, Sanders C, et al. The effect of the hurricane Katrina disaster on sexual behavior and access to reproductive care for young women in New Orleans. *Sex Transm Dis*. 2007; 34(11):883–6. [PubMed: 17579338]
36. Rogal SS, Poschman K, Belanger K, et al. Effects of posttraumatic stress disorder on pregnancy outcomes. *J Affect Disord*. 2007; 102(1-3):137–43. [PubMed: 17291588]

37. Morland L, Goebert D, Onoye J, et al. Posttraumatic stress disorder and pregnancy health: Preliminary update and implications. *Psychosomatics*. 2007; 48(4):304–8. [PubMed: 17600166]
38. Rose D, Bodor JN, Rice JC, et al. The effects of Hurricane Katrina on food access disparities in New Orleans. *Am J Public Health*. 2011; 101(3):482–4. doi:10.2105/ajph.2010.196659. [PubMed: 21233432]
39. Lowe SR, Chan CS, Rhodes JE. The Impact of Child-Related Stressors on the Psychological Functioning of Lower-Income Mothers After Hurricane Katrina. *Journal of family issues*. 2011; 32(10):1303–24. doi:10.1177/0192513x11412492. [PubMed: 22383861]
40. Rendall MS. Break-up of New Orleans Households after Hurricane Katrina. *J Marriage Fam*. 2011; 73(3):654–68. doi:10.1111/j.1741-3737.2011.00837.x. [PubMed: 21709733]
41. Harville EW, Taylor CA, Tesfai H, et al. Experience of Hurricane Katrina and reported intimate partner violence. *J Interpers Violence*. 2011; 26(4):833–45. doi:10.1177/0886260510365861. [PubMed: 20495099]
42. Dunkel Schetter C. Psychological science on pregnancy: stress processes, biopsychosocial models, and emerging research issues. *Annu Rev Psychol*. 2011; 62:531–58. doi:10.1146/annurev.psych.031809.130727 [doi]. [PubMed: 21126184]

Table 1

Participants in a study of prenatal care and birth outcomes after Hurricane Katrina, 2010-2012 (n=297).

	N*	%
Age category		
<=20	43	14.5
>20-25	94	31.8
>25-30	88	29.7
>30	71	24.0
Race/ethnicity		
white non-Hispanic	78	26.3
black non-Hispanic	174	58.6
Hispanic	45	15.2
Education		
<high school	67	22.8
high school	77	26.2
>high school	150	51.0
Relationship status		
married	80	27.4
living with partner	88	30.1
single, divorced, or widowed	124	42.5
Income		
<\$15,000	147	52.7
\$15-29,000	56	20.1
>\$30,000	76	27.2
Parity		
primiparous	174	59.8
multiparous	117	40.2
Smoke		
yes	30	10.2
no	265	89.8
Currently employed		
yes	113	38.2
no	183	61.8
Lived in New Orleans prior to August 2005		
yes	209	70.4
no	88	29.6
How soon returned/moved to New Orleans after Katrina		
<1 years	120	40.4
1-2 years	94	31.7

	N*	%
3-4 years	49	16.5
5+ years	34	11.4
How is your personal situation in terms of recovering from Hurricane Katrina?		
largely back to normal	95	36.1
almost back to normal	72	27.4
still somewhat disrupted	71	27.0
still very disrupted	25	9.5
How worried are you that another hurricane will hit this area?		
very	108	37.5
somewhat	116	40.3
not too much	51	17.7
not at all	13	4.5
How worried are you that you won't have enough income to meet all your needs?		
very	92	31.6
somewhat	108	37.1
not too much	55	18.9
not at all	36	12.4
How worried are you that health care services may not be available?		
very	81	28.3
somewhat	92	32.2
not too much	64	22.4
not at all	49	17.1
How worried are you that you won't be able to find a place to live?		
very	99	34.5
somewhat	79	27.5
not too much	47	16.4
not at all	62	21.6
Satisfaction with parish and pace of recovery		
satisfied/high recovery	100	34.3
satisfied/medium recovery	129	44.2
dissatisfied/low recovery	63	21.6
Depression	90	30.3
PTSD	27	9.1
Pregnancy-related anxiety	52	17.5
Low birthweight	19	6.4

	N*	%			
Preterm birth	19	6.6			
	mean	median	sd	min	max
Birthweight	3212	3250	471	1669	4470
Gestational age	273.1	274.5	9.9	233.0	293.0
Birth length	50.0	50.0	2.4	43.5	57.0
Head circumference	33.7	33.5	1.6	29.0	37.0

* Data may not add to 297 due to missing data

Recovery experience and infant outcomes among pregnant women in post-Katrina New Orleans, 2010-2012 (n=297)

Table 2

	birthweight (g)						gestational age (days)					
	unadjusted			adjusted ^a			unadjusted			adjusted		
	beta	sd	p	beta	sd	p	beta	sd	p	beta	sd	p
Life disrupted	-60	60	0.32	6	62	0.93	-1.47	1.31	0.26	-0.94	1.38	0.50
very worried another hurricane will hit the region	-72	67	0.28	-112	65	0.08	-2.82	1.42	0.05	-3.20	1.41	0.02
overall resource deficit (high)	-58	63	0.35	-41	65	0.53	-1.66	1.35	0.22	-2.28	1.41	0.11
overall resource deficit (continuous)	10	10	0.32	6	11	0.57	0.09	0.22	0.67	0.20	0.24	0.41
Satisfaction with parish and pace of recovery												
satisfied/high recovery	ref		0.06			0.19			0.45			0.44
satisfied/medium recovery	-104	62		-74	62		-0.82	1.33		-0.76	1.33	
dissatisfied/low recovery	-172	75		-93	76		-2.01	1.59		-1.20	1.63	
	length (cm)						head circumference (cm)					
	unadjusted			adjusted			unadjusted			adjusted		
	beta	sd	p	beta	sd	p	beta	sd	p	beta	sd	p
Life disrupted	-0.44	0.32	0.18	0.12	0.33	0.71	-0.40	0.21	0.06	-0.16	0.22	0.46
very worried another hurricane will hit the region	-0.51	0.35	0.15	-0.65	0.34	0.06	-0.27	0.23	0.25	-0.41	0.23	0.07
overall resource deficit (high)	-0.10	0.33	0.77	0.39	0.34	0.25	-0.59	0.22	0.01	-0.55	0.23	0.02
overall resource deficit (continuous)	0.06	0.05	0.31	-0.05	0.06	0.42	0.08	0.04	0.02	0.07	0.04	0.06
Satisfaction with parish and pace of recovery												
satisfied/high recovery			0.39			0.98			0.40			0.57

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

satisfied/medium recovery	-0.27	0.33	-0.05	0.32	-0.27	0.22	-0.20	0.22
dissatisfied/low recovery	-0.55	0.40	0.03	0.40	-0.02	0.27	0.22	0.27

^a adjusted for age, marital status, educational level, race, smoking, and income

Mental health and infant outcomes among pregnant women after Hurricane Katrina, 2010-2012, n=297

Table 3

	birthweight (g)						gestational age (days)					
	unadjusted			adjusted			unadjusted			adjusted		
	beta	sd	p	beta	sd	p	beta	sd	p	beta	sd	p
depression	-45	59	0.45	33	64	0.60	-0.90	1.26	0.47	-0.37	1.39	0.79
PTSD	-34	95	0.72	50	96	0.60	-2.85	2.02	0.16	-2.85	2.07	0.17
pregnancy-related anxiety	-20	72	0.78	38	71	0.59	-1.73	1.52	0.26	-1.21	1.53	0.43
	length (cm)						head circumference (cm)					
	unadjusted			adjusted			unadjusted			adjusted		
	beta	sd	p	beta	sd	p	beta	sd	p	beta	sd	p
depression	-0.23	0.32	0.47	0.45	0.34	0.18	-0.52	0.21	0.01	-0.26	0.23	0.26
PTSD	-0.27	0.51	0.60	0.53	0.51	0.30	-0.30	0.35	0.39	0.00	0.35	1.00
pregnancy-related anxiety	0.12	0.39	0.76	0.58	0.37	0.12	0.00	0.26	0.99	0.22	0.25	0.38

Table 4

Experience of Hurricane Katrina and infant outcomes among New Orleans pregnant women, 2010-2012, n=297

	birthweight								
	unadjusted			adjusted ^a			adjusted + resource deficit ^b		
	beta	sd	p for trend	beta	sd	p for trend	beta	sd	p for trend
danger			0.03			0.66			0.68
low	0								
medium	-144	74		-63	76		-63	78	
high	-122	65		-19	73		-24	75	
damage			<0.01			0.06			0.05
low	0								
medium	-140	71		-71	82		-65	82	
high	-270	71		-156	87		-158	86	
injury			0.05			0.56			0.63
low	0								
medium	-86	71		-1	72		12	73	
high	-132	77		-53	79		-48	80	
	gestational age								
	unadjusted			adjusted			adjusted + resource deficit		
	beta	sd	p for trend	beta	sd	p for trend	beta	sd	p for trend
danger			0.14			0.28			0.29
low	0.0								
medium	-3.8	1.6		-3.2	1.6		-3.2	1.7	
high	-1.5	1.4		-1.3	1.6		-1.4	1.6	
damage			0.07			0.36			0.34
low	0.0								
medium	-2.2	1.5		-0.4	1.8		-0.3	1.8	
high	-2.9	1.5		-1.5	1.9		-1.5	1.9	
injury			<0.01			<0.01			<0.01
low	0.0								
medium	-1.0	1.5		-0.7	1.5		-0.4	1.5	
high	-5.1	1.6		-5.0	1.7		-4.9	1.7	
	length								
	unadjusted			adjusted			adjusted + resource deficit		
	beta	sd	p for trend	beta	sd	p for trend	beta	sd	p for trend
danger			0.02			0.88			0.64
low	0.00								
medium	-0.26	0.39		0.15	0.39		0.04	0.40	
high	-0.82	0.35		-0.08	0.39		-0.20	0.39	
damage			0.02			0.43			0.37

low	0.00								
medium	−0.31	0.38		−0.17	0.43		−0.14	0.43	
high	−0.88	0.38		−0.34	0.45		−0.37	0.45	
injury			0.01			0.33			0.30
low	0.00								
medium	−0.77	0.37		−0.29	0.37		−0.21	0.37	
high	−0.82	0.41		−0.35	0.42		−0.42	0.42	
head circumference									
	unadjusted			adjusted			adjusted + resource deficit		
	beta	sd	p for trend	beta	sd	p for trend	beta	sd	p for trend
danger			<0.01			0.09			0.20
low	0.00								
medium	−0.37	0.26		−0.14	0.26		−0.05	−0.27	
high	−0.78	0.23		−0.44	0.26		−0.36	0.26	
damage			<0.01			0.26			0.27
low	0.00								
medium	−0.45	0.25		−0.37	0.29		−0.38	0.29	
high	−0.76	0.25		−0.40	0.30		−0.39	0.30	
injury			<0.01			0.09			0.14
low	0.00								
medium	−0.41	0.25		−0.13	0.25		−0.15	0.26	
high	−0.75	0.27		−0.48	0.28		−0.42	0.28	

^a adjusted for age, race/ethnicity, income, education, smoking, and marital status

^b economic resource deficit was created as the sum of reported worry about not having sufficient income, accessing health care, and having a place to live.