

Health Concerns of Women and Infants in Times of Natural Disasters: Lessons Learned from Hurricane Katrina

William M. Callaghan · Sonja A. Rasmussen · Denise J. Jamieson ·
Stephanie J. Ventura · Sherry L. Farr · Paul D. Sutton · Thomas J. Mathews ·
Brady E. Hamilton · Katherine R. Shealy · Dabo Brantley · Sam F. Posner

Published online: 26 January 2007
© Springer Science+Business Media, LLC 2007

Abstract Pregnant women and infants have unique health concerns in the aftermath of a natural disaster such as Hurricane Katrina. Although exact numbers are lacking, we estimate that approximately 56,000 pregnant women and 75,000 infants were directly affected by the hurricane. Disruptions in the supply of clean water for drinking and bathing, inadequate access to safe food, exposure to environmental toxins, interruption of health care, crowded conditions in shelters, and disruption of public health and clinical care infrastructure posed threats to these vulnerable populations. This report cites the example of Hurricane Katrina to focus on the needs of pregnant women and infants during times of natural disasters and provides considerations for those who plan for the response to these events.

Keywords Hurricane Katrina · Pregnant women and infants · Natural disasters

Hurricane Katrina made landfall on the U.S. Gulf Coast August 29, 2005, devastating the region, particularly along the Louisiana, Mississippi, and Alabama coasts. By September 23, 2005, 75 parishes or counties were directly affected by the hurricane and declared Federal Disaster Areas qualifying for individual and public assistance [1]. The effects of Hurricane Katrina on injuries, environmental exposures, and infectious diseases have been reported [2–7] and previously published articles highlight the unique health care needs of Gulf Coast and evacuee populations with diabetes, [8] genetic and metabolic diseases, [9] and other chronic diseases such as heart disease, hypertension, stroke, and asthma [10–11]. Although much less has been published regarding the impact of Hurricane Katrina on pregnant women and their infants, Buekens and colleagues recently emphasized the importance of research on the hurricane's effects on these populations [12]. Although disasters are largely unpredictable, hurricane season in the United States occurs yearly. Moreover, large scale natural disasters are not infrequent in the United States; the National Oceanic and Atmospheric Administration's National Climatic Data Center reported 67 billion dollar climate and weather disasters between 1980 and 2005 [13]. As such it is critical that we learn from experiences during Hurricane Katrina in order to better plan responses for future hurricanes and other disasters.

Exposure to environmental contaminants, psychological stress, and lack of access to health care and medications during a disaster have potential serious consequences for pregnant women and infants [14]. Adverse pregnancy events such as intrauterine growth restriction, [15–16] decreased birth weight and head circumference, [17–18] and increased infant cortisol level [19] may have been associated with

W. M. Callaghan (✉) · D. J. Jamieson · S. L. Farr · D. Brantley ·
S. F. Posner
Division of Reproductive Health, National Center for Chronic
Disease Prevention and Health Promotion, Centers for Disease
Control and Prevention,
4770 Buford Hwy MS K-23, Atlanta, GA 30341
e-mail: wcallaghan@cdc.gov

S. A. Rasmussen
Division of Birth Defects and Developmental Disabilities,
National Center on Birth Defects and Developmental Disabilities,
Centers for Disease Control and Prevention,
Atlanta, GA

S. J. Ventura · P. D. Sutton · T. J. Mathews · B. E. Hamilton
Division of Vital Statistics, National Center for Health Statistics,
Centers for Disease Control and Prevention,
Hyattsville, Maryland

K. R. Shealy
Division of Nutrition and Physical Activity, National Center for
Chronic Disease Prevention and Health Promotion, Centers for
Disease Control and Prevention,
Atlanta, GA

exposure to the World Trade Center events of 2001. Additionally, increased rates of spontaneous abortion, [20] orofacial clefts, [21] and neural tube defects [22] have been seen in populations following floods, earthquakes, and hurricanes. Post-Hurricane Katrina surveillance in Colorado found that 3% of emergency room visits by Katrina evacuees were for obstetric reasons and 13–15% of evacuee households were in need of services related to the special supplemental nutrition program for Women, Infants, and Children (WIC), birth control and reproductive health, and child care [7].

This report serves to raise awareness that pregnant women and infants are a special population with unique needs. As such, we outline the historic risk of adverse pregnancy outcomes and low breastfeeding rates from population-based data in the affected areas. We then briefly review how the Centers for Disease Control and Prevention (CDC) and other public health agencies responded to the urgent needs of pregnant women and their infants following Hurricane Katrina. Finally, using Hurricane Katrina and its aftermath as a paradigm, we suggest considerations for addressing the needs of pregnant women, infants, and breastfeeding mothers when preparing for disaster response.

The population at risk

It is estimated that more than 1.1 million women of reproductive age (15–44 years) resided in the affected areas before the storm [23]. Among women living in these areas there were 74,859 live births in 2003 [24]. In that approximately three-fourths of women who give birth in a one year period are pregnant at any point in time, there would be an estimated 56,100 pregnant women and 74,900 infants who were directly affected by the hurricane. Although exact estimates are lacking, many pregnant women in affected areas were displaced from their homes. Within 2 weeks of the hurricane more than 600 shelters were accommodating more than 200,000 evacuees in up to 18 states [25]. By the end of September, evacuees were living in nearly all 48 contiguous states [1]. In addition, some pregnant women probably remained in their homes, many of them cut off from essential services such as electricity and potable water as well as prenatal and other medical care.

Historic data have shown that women living in Louisiana, Mississippi, and Alabama are at greater risk for adverse pregnancy and infant outcomes than women in the general U.S. population [24]. Further, rates of adverse outcomes are higher in the Katrina-affected counties and parishes of these three states than overall rates for each of the states. Women living in the affected areas were more likely than women nationally to give birth to low birthweight infants (<2,500 g) and very low birthweight infants (<1500 g) (Table 1). The infant mortality rate for the affected areas was

Table 1 Percentage of preterm, low birthweight, and very low birthweight infants in counties and parishes affected by Hurricane Katrina—2003

	In areas affected by Hurricane Katrina*	In Alabama, Louisiana, and Mississippi	In United States
Number of births	74,859	166,972	4,089,950
Percent low birthweight**	11.1	10.6	7.9
Percent very low birthweight***	2.3	2.1	1.4
Percent preterm****	16.9	16.2	12.3

Source. National Vital Statistics System, National Center for Health Statistics, Centers for Disease Control and Prevention.

*FEMA-designated counties/parishes as of September 23, 2005. In Alabama—Baldwin, Choctaw, Clarke, Mobile, Pickens, Greene, Hale, Sumter, Tuscaloosa, and Washington Counties. In Louisiana—the parishes of Ascension, Assumption, East Baton Rouge, Iberia, Iberville, Jefferson, Lafourche, Livingston, Orleans, Plaquemines, St. Bernard, St. Charles, St. Helena, St. James, St. John the Baptist, St. Mary, St. Martin, St. Tammany, Tangipahoa, Terrebonne, Washington, and West Baton Rouge. In Mississippi—Adams, Amite, Claiborne, Clarke, Copiah, Covington, Forrest, Franklin, George, Greene, Hancock, Harrison, Hinds, Jackson, Jasper, Jefferson, Jefferson Davis, Jones, Kemper, Lamar, Lauderdale, Lawrence, Leake, Lincoln, Lowndes, Madison, Marion, Neshoba, Newton, Noxubee, Oktibbeha, Pearl River, Perry, Pike, Rankin, Scott, Simpson, Smith, Stone, Walthall, Wayne, Wilkinson, and Winston Counties.

**Birth weight of <2,500 g.

***Birth weight of <1,500 g.

****Gestation of <37 completed weeks.

9.4 per 1,000 live births in 2002 compared with a national rate of 7.0. [26] Women living in the hurricane-affected areas are also at greater risk for not breastfeeding and for shorter duration of breastfeeding compared with women nationally. In 2004, data from the CDC National Immunization Survey showed that 51.3% of infants in Alabama, Mississippi, and Louisiana were ever breastfed, compared with 70.3% nationwide [27]. Only 7.0% of infants in hurricane-affected states were breastfed the recommended 12 months, compared with 17.8% nationally. Therefore, Hurricane Katrina affected a large number of pregnant women and infants already at high risk for adverse outcomes.

The CDC and public health response

In response to the events precipitated by Hurricane Katrina, CDC formed a multidisciplinary, cross-agency response group to address the urgent needs of pregnant women and infants. A fact sheet for pregnant women was incorporated into a packet of materials for distribution to evacuees, and a public service announcement with basic messages for pregnant women was broadcast in areas where large numbers of evacuees were relocated. The fact sheet was

designed to aid non-obstetric health care providers in triaging pregnant women and providing basic prenatal services (<http://www.bt.cdc.gov/disasters/pregnantdisasterhcp.asp>). The fact sheet emphasized awareness of the possibility of pregnancy, re-instituting prenatal services for women whose care was interrupted, basic trimester-appropriate components of prenatal care, and signs and symptoms that should prompt urgent referral to a facility equipped to deal with acute obstetric care.

Free telephone counseling about the effects of specific exposures on pregnancy or lactation was made available to women and their health care providers, under a CDC contract with the Organization of Teratology Information Specialists (OTIS) (www.otispregnancy.org). Extensive information on potential exposures and what was known about their impact on the pregnant woman and fetus was made available as fact sheets on OTIS's website. CDC also published guidelines on its website for non-obstetric providers about care of pregnant women, and distributed information about infant feeding, stressing the importance of continuing breastfeeding and offering recommendations for using infant formula (e.g., using ready-to-feed formula, cleaning bottles).

Implications

Pregnant women and infants have unique health concerns in the aftermath of a natural disaster such as Hurricane Katrina. Disruptions in the supply of clean water for drinking and bathing, inadequate access to safe food, exposure to environmental toxins (e.g. carbon monoxide due to the inappropriate indoor use of devices powered by liquid fuels and natural gas), interruption of health care, crowded conditions in shelters, and disruption of public health and clinical care infrastructure posed threats to these vulnerable populations. Loss of electricity limits access to information and strategies to address the challenges to dissemination must be addressed. Some basic considerations regarding the needs of pregnant women and infants following natural disasters are listed in Table 2.

Addressing the special circumstance of pregnancy requires the recognition among responders that a proportion of women of childbearing age in any population at any given time are pregnant and that many women may not recognize their pregnancies during the early weeks, a time critical for embryogenesis. Most disaster medical assistance team members and other health care providers deployed in disasters triage by acuity. It is crucial that these health care providers also consider whether a woman may be pregnant so they can evaluate pregnancy-related issues and refer pregnant women to appropriate prenatal/obstetric care as quickly as possible. As people in shelters or health care facilities are being evaluated and processed, medical intake information collected

Table 2 Considerations for pregnant women and infants when preparing and responding to natural disasters

-
- Ascertain pregnancy status as part of medical intake process.
 - Consider contraceptive needs for evacuated women in order to avoid unintended pregnancies.
 - Promote continuation of exclusive breastfeeding.
 - Understand the impact on infants and pregnant women of disrupting the public health and clinical care infrastructures. For prenatal care, this may involve training non-obstetrical healthcare providers to effectively triage pregnant women.
 - Recognize the effects of exposures related to the disaster (e.g., vaccinations and medications used in the public health response) on pregnant women and their infants. Ensure that information about the effects of these exposures is available to women and their health care providers.
 - Determine the feasibility of establishing a pregnancy registry early in the event to track outcomes for pregnant women.
 - Equip disaster medical assistance teams and other response teams with awareness of and capabilities for managing pregnant and lactating women and their infants.
-

as part of surveillance of medical care should include a question about pregnancy status: "Are you or do you think you could be pregnant?" with possible responses of yes, no, or not sure. Having urine pregnancy tests available for women who respond that they are not sure of their pregnancy status will verify pregnancy status and ensure that appropriate care is provided. That we cannot account for pregnancy outcomes for women who were exposed to the hurricane and her aftermath is understandable, given the massive evacuation and dispersion of the population. However, if there can ever be any chance of tracking pregnant women in times of disaster, it must begin with ascertainment of pregnancy status.

In addition to the health care needs of women who are already pregnant, health care needs of women who wish to avoid an unintended pregnancy are also important, because unintended pregnancy is associated with increased maternal morbidity and health behaviors during pregnancy that are associated with adverse effects for women and infants. Because women may not have access to their preferred contraceptive method, public health planning for natural disasters should consider strategies for providing access to contraception, including methods requiring a prescription.

Natural disasters such as Hurricane Katrina can result in a substantial disruption of the public health and clinical infrastructures that are necessary for prenatal, intrapartum, and postpartum care. Women remaining in the affected area may need to find a new local source of care, and displaced women will need to find a provider in their new location. Access to existing prenatal care records may be limited, and referral of these women to new providers needs to occur quickly, in recognition of critical windows for prenatal testing (e.g., maternal serum screening at 16–18 weeks) and risk assessment.

Women with diabetes mellitus, chronic hypertension, and other medical complications will require prompt identification and referral. In addition to prenatal care, many pregnant women are faced with finding a new local source for labor and delivery services.

Teams conducting mass vaccination campaigns, such as those that occurred in some shelters, should consider that vaccines for varicella and for measles, mumps, and rubella (MMR) are not recommended for pregnant women [28]. Health care staff must be able to discuss with women risks of vaccination versus risks of diseases. In addition, certain drugs used to treat infections, such as doxycycline for treatment of *Vibrio vulnificus* infections, may not be the best choice during pregnancy. Health care providers and pharmacists treating patients for infections during a disaster situation should have access to information about the risks of certain medications to the fetus so they can provide appropriate treatment.

Issues related to infant feeding also need to be considered. The CDC and the American Academy of Pediatrics recommend breastfeeding for optimal infant and child health, [29] and breastfeeding remains the best option in a natural disaster situation. Some women may have concerns about breastfeeding their infant after exposure to chemicals in flood water or when experiencing diarrhea or a food-borne illness. However, the benefits of breastfeeding outweigh the risks of exposure to chemical toxins through breast milk [30]. Information on medications and their use during lactation should be made available. Breastfeeding women with diarrhea should be encouraged to increase fluid intake [31]. Oral rehydration salts, Kaolin-pectin (Kaopectate) and loperamide (Imodium) are compatible with breastfeeding; however, some antidiarrheal treatments such as bismuth subsalicylate compounds (Pepto-Bismol) are not recommended [31]. Access to clean water was limited during the hurricane's aftermath, making infant formula preparation difficult. In such cases, ready-to-feed infant formula in single-serving feeding bottles is recommended because of concerns about water safety, lack of refrigeration, and limited access to cleaning agents.

Other important impacts on pregnant women and infants occurred because of the hurricane's impact on the public health infrastructure. One example is disruption of the Louisiana Newborn Screening and Follow-up Program [9]. Newborn screening allows early identification and treatment of conditions that result in mental retardation or life-threatening conditions if untreated. The state identified a time period during which testing was not performed or results were not provided to the health care provider.

The events before, during, and after Hurricane Katrina also serve to highlight the need for women, families, communities, and public health agencies to be proactive in their preparations for natural disasters. In addition to the general guidelines, such as planning for evacuation routes that are issued by the Federal Emergency Manage-

ment Agency (<http://www.fema.gov/plan/index.shtm>), pregnant women can obtain copies of medical records when they have a reasonable warning that evacuation or other disruption of care is imminent. Moreover, women who are pregnant might consider early evacuation from areas at risk when events such as hurricanes are predicted. Pregnant women and women with infants who require medications should be encouraged to have emergency supplies and knowledge of dosages. Personal and community reserves of ready-to-feed infant formula can provide critical nutritional needs when breastfeeding is not an option.

All people affected by natural disasters have needs, and events like Hurricane Katrina will challenge even the greatest efforts of those charged with the responsibility to prepare and to react. However, women and infants require unique efforts. The public health response on all levels must incorporate their needs as we plan our strategies for responding to natural disasters.

References

1. Federal Emergency Management Agency. 2005 Federal Disaster Declarations. Available at <http://www.fema.gov/news/disasters.fema?year=2005>.
2. CDC. Injury and illness surveillance in hospitals and acute-care facilities after Hurricanes Katrina and Rita – New Orleans Area, Louisiana, September 25–October 15, 2005. *MMWR* 2006;55:35–38.
3. CDC. Two cases of toxigenic *Vibrio cholerae* 01 infection after Hurricanes Katrina and Rita - Louisiana, October 2005. *MMWR* 2006;55:31–2.
4. CDC. Surveillance for illness and injury after Hurricane Katrina—Three counties, Mississippi, September 5 – October 11, 2005. *MMWR* 2006;55:231–4.
5. CDC. Carbon monoxide poisonings after two major hurricanes - Alabama and Texas, August – October 2005. *MMWR* 2006;55:236–9.
6. CDC. Mortality associated with Hurricane Katrina—Florida and Alabama, August–October 2005. *MMWR* 2006; 55:239–42.
7. CDC. Illness surveillance and rapid needs assessment among Hurricane Katrina evacuees—Colorado, September 1–23, 2005. *MMWR* 2006;55:244–7.
8. Cefalu WT, Smith SR, Blonde L, Fonseca V. The hurricane Katrina aftermath and its impact on diabetes care: observations from “ground zero”: lessons in disaster preparedness of people with diabetes. *Diabetes Care* 2006;29:158–60.
9. Andersson HC, Narumanchi TC, Cunningham A, Bowdish B, Thoene J. Genetic/metabolic health care delivery during and after hurricanes Katrina and Rita. *Mol Genet Metab* 2006;88:3–6.
10. Ford ES, Mokdad AH, Link MW, Garvin WS, McGuire LC, Jiles RB, Balluz LS. Chronic disease in health emergencies: in the eye of the hurricane. *PCD* April 2006 3(2):1–7.
11. Mokdad AH, Mensah GA, Posner SF, Reed E, Simoes EJ, Engelgau MM, et al. When chronic conditions become acute: prevention and control of chronic diseases and adverse health outcomes during natural disasters. *PCD* Nov 2005 2(special issue):1–4.
12. Buekens P, Xiong X, Harville E. Hurricanes and Pregnancy. *Birth* 2006;33:91–3.
13. National Climatic Data Center. Billion Dollar Climate and Weather Disasters 1980–2005. Available at <http://www.ncdc.noaa.gov/oa/reports/billionz.html>.

14. Cordero JF. The epidemiology of disasters and adverse reproductive outcomes: lessons learned. *Environ Health Perspect* 1993;101 (Suppl 2):131–6.
15. Berkowitz GS, Wolff MS, Janevic TM, Holzman IR, Yehuda R, Landrigan PJ. The World Trade Center disaster and intrauterine growth restriction. *JAMA (Letter to the Editor)* Aug 2003;290(5):595–6.
16. Perera FP, Tang D, Lester RV, Tsai WY, Tu YH, Weiss L, Hoepner L, King J, Del Priore G, Lederman SA. Relationships among polycyclic aromatic hydrocarbon-DNA adducts, proximity to the World Trade Center, and effects on fetal growth. *Environ Health Perspect* Aug 2005;113(8):1062–7.
17. Lederman SA, Rauh V, Weiss L, Stein JL, Hoepner LA, Becker M, Perera FP. The effects of the World Trade Center event on birth outcomes among term deliveries at three lower Manhattan hospitals. *Environ Health Perspect* Dec 2004;112(17):1772–7.
18. Engel SM, Berkowitz GS, Wolff M, Yehuda R. Psychological trauma associated with the World Trade Center attacks and its effect on pregnancy outcome. *Paediatr Perinat Epidemiol* 2005;19:334–41.
19. Yehuda R, Engel SM, Brand SR, Seckl J, Marcus SM, Berkowitz GS. Transgenerational effects of posttraumatic stress disorder in babies of mothers exposed to the World Trade Center attacks during pregnancy. *JCEM (Brief Report)* 2005;90(7):4115–8.
20. Janerich DT, Stark AD, Greenwalk P, Burnett WS, Jacobson HI, McCusker J. Increased leukemia, lymphoma, and spontaneous abortion in Western New York following a flood disaster. *Public Health Rep* 1981;96(4):350–6.
21. Montenegro MA, Palomino H, Palomino HM. The influence of earthquake-induced stress on human facial clefting and its simulation in mice. *Achs oral Biol* 1995;40(1):33–7.
22. Duff EM, Cooper ES. Neural tube defects in Jamaica following Hurricane Gilbert. *AJPH* Mar 1994;84(3):473–6.
23. National Center for Health Statistics. Postcensal estimates of the resident population of the United States as of July 1, 2003, by year, state, and county, age, bridged race, sex, and Hispanic origin (vintage 2003). September 14, 2004. Available at <http://www.cdc.gov/nchs/about/major/dvs/popbridge/datadoc.htm>.
24. National Vital Statistics System, National Center for Health Statistics. Unpublished data from the 2003 natality historical file. 2005.
25. CDC. Update on CDC's response to hurricane Katrina. September 12, 2005. Available at <http://www.cdc.gov/od/katrina/archive.htm>.
26. National Vital Statistics System, National Center for Vital Statistics. Unpublished data from 2002 linked birth/infant death historical file. 2005.
27. CDC. Breastfeeding: Data and Statistics: Breastfeeding Practices—Results from the National Immunization Survey. Available at http://www.cdc.gov/breastfeeding/data/NIS_data/index.htm.
28. CDC. Guidelines for Vaccinating Pregnant Women. Available at http://www.cdc.gov/nip/publications/preg_guide.htm.
29. CDC. Breastfeeding: Policies. Available at <http://www.cdc.gov/breastfeeding/policies/index.htm>.
30. CDC. Breastfeeding: Infectious Diseases and Specific Conditions Affecting Human Milk: Exposure to Environmental Toxins. Available at http://www.cdc.gov/breastfeeding/disease/environmental_toxins.htm.
31. CDC. Breastfeeding: Infectious Diseases and Specific Conditions Affecting Human Milk: Food-borne and Waterborne Illness during Breastfeeding. Available at <http://www.cdc.gov/breastfeeding/disease/illness.htm>.