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Changes in Breastfeeding and Related Maternity Care Practices After Hurricanes Irma and Maria in Puerto Rico

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Abstract

Background: Breastfeeding is recommended globally for most infants, especially during and after natural disasters when risk of adverse outcomes increases because of unsanitary conditions and lack of potable water.
Materials and Methods: Using 2017–2019 data from Puerto Rico's Pregnancy Risk Assessment Monitoring System for 2,448 respondents with a recent live birth, we classified respondents into 4 hurricane exposure time periods based on infant birth month and year relative to when Hurricanes Irma and Maria occurred: (1) prehurricane; (2) acute hurricane; (3) posthurricane, early recovery; and (4) posthurricane, long-term recovery. We examined the association between maternity care practices during delivery hospitalization and exclusive breastfeeding at 3 months overall and stratified by time period. We also examined the associations between each maternity care practice and exclusive breastfeeding separately by time period.
Results: Exclusive breastfeeding at 3 months was higher during the acute hurricane time period (adjusted prevalence ratio [aPR]: 1.43, 95% confidence interval: 1.09–1.87) than the prehurricane time period. Supportive maternity care practices were positively associated with exclusively breastfeeding, and practices that are risk factors for discontinuing breastfeeding were negatively associated with exclusive breastfeeding. Breastfeeding in the first hour (aPR range: 1.51–1.92) and rooming-in (aPR range: 1.50–2.58) were positively associated with exclusive breastfeeding across all time periods, except the prehurricane time period. Receipt of a gift pack with formula was negatively associated with exclusive breastfeeding (aPR range: 0.22–0.54) across all time periods.
Conclusions: Maternity care practices during delivery hospitalization may influence breastfeeding behaviors and can improve breastfeeding during and after natural disasters. Strategies to maintain and improve these practices can be further supported during and after natural disasters.

Keywords: PRAMS, breastfeeding, hurricanes, maternity care practices

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Introduction

Natural disasters (e.g., hurricanes, floods, and wildfires) can affect a community's essential infrastructures (e.g., electricity, health care, sanitation), and have deleterious effects on public health.[1] The public health impacts of natural disasters, such as limited access to potable water and food, increased risk of infections, and lack of or disrupted access to health care, can pose specific challenges for women during and after pregnancy and to infants.[2–4] Human milk is recommended globally for most infants,[5–7] particularly during and after natural disasters.[8,9] Infants who receive human milk have a lower risk of illnesses and diseases, such as diarrhea and respiratory infections.[10–14] Proper preparation of powdered infant formula requires potable water, access to a clean space to prepare formula, and supplies for sanitizing infant feeding items. These supplies might not be readily available during and after a natural disaster,[15] increasing the risk of adverse outcomes among infants who are formula fed.[2–4,16]

Although ready-to-feed infant formula is a safer alternative to powdered formula, this might not be available or sustainable because of storage requirements, costs, and accessibility during natural disasters.[8,17,18] Breastfeeding is the safest option to provide adequate infant nutrition during public health emergencies[8] as it offers infants the greatest protection against diarrhea and respiratory infections, which have been linked to higher rates of infant mortality.[19,20]

One mechanism to improve breastfeeding rates is through supportive maternity care practices during and after delivery.[21–23] Maternity care facilities (i.e., hospitals and birth centers) can support women to breastfeed by implementing evidence-based maternity care practices outlined in the Ten Steps to Successful Breastfeeding (*Ten Steps*) and discontinuing practices that are detrimental to breastfeeding (e.g., medically unnecessary formula supplementation and gifting of free infant formula).[21]

During September 5–7, 2017, Hurricane Irma, although not making landfall, resulted in widespread power outages across Puerto Rico.[24] Less than 2 weeks later, Hurricane Maria made landfall on September 20, 2017, as a category 4 hurricane, devastating the island. Nearly all residents lost power and experienced challenges obtaining food, potable water, and other essential services (e.g., health care). Among women who were pregnant at landfall, 97% reported losing power for more than a week, >50% reported trouble getting potable water, and 35% reported housing disruption.[25] By the end of 2017, nearly half of residents remained without power, and service was only restored to 65% of residents by the end of January 2018.[26] In addition, individuals without access to potable water often obtained water from natural untreated freshwater sources (e.g., ponds, streams, lakes) that could increase the risk of infections.[27,28]

Little is known about how infant feeding and maternity care practices were affected in the aftermath of the hurricanes. The environment after Hurricane Maria resulted in early hospital discharges; therefore, we hypothesized that the quantity and quality of how practices were delivered might have been affected, which could affect how these practices were associated with breastfeeding.

We examined the associations between maternity care practices during delivery hospitalization and exclusive breastfeeding at 3 months overall and stratified by time period relative to when Hurricane Irma and Maria occurred (i.e., hurricane exposure time period) among women with a recent live birth in Puerto Rico. We also examined the associations between maternity care practices and exclusive breastfeeding at 3 months separately by time period.

Materials and Methods

Data sources and study population

We analyzed 2017–2019 data for Puerto Rico from the Pregnancy Risk Assessment Monitoring System (PRAMS), a population-based surveillance system conducted by the Centers for Disease Control and Prevention (CDC) in collaboration with participating sites. In early 2017, Puerto Rico first implemented PRAMS, which assesses maternal behaviors and experiences before, during, and shortly after pregnancy. In addition to the core questionnaire, which all PRAMS sites include on their site-specific questionnaire, Puerto Rico also included optional, standard questions that measured breastfeeding exclusivity and respondents self-reported experience of maternity care practices in the hospital. PRAMS randomly samples women from birth certificates and contacts them 2–6 months postpartum to participate. Respondents can complete the PRAMS survey via mail or telephone. PRAMS methodology has been described in detail elsewhere.[29]

Outcomes

Exclusive breastfeeding at 3 months. We created a dichotomous yes–no indicator for exclusive breastfeeding at 3 months for respondents who completed the PRAMS survey at or after 3 months postpartum. Exclusive breastfeeding is defined as the infant having received only breast milk with no other liquids or solid foods.[7] Respondents who were not living with their infant or whose infant was deceased at the time they completed the survey were instructed to skip breastfeeding-related questions and were excluded from analyses. The remaining respondents were asked, ''Did you ever breastfeed or pump breast milk to feed your new baby, even for a short period of time?'' Respondents who answered ''Yes'' were asked, ''Are you currently breastfeeding or feeding pumped milk to your new baby?'' Respondents who answered ''No'' were asked: ''How many weeks or months did you breastfeed or feed pumped milk to your baby?''

Respondents who initiated breastfeeding were also asked, ''How old was your new baby the first time he or she had liquids other than breast milk (such as formula, water, juice, or cow's milk)?'' All respondents were asked, ''How old was your new baby the first time he or she ate food (such as baby cereal, baby food, or any other food)?'' Respondents who reported their infant had been introduced to liquids other than breast milk or any other food before or at 3 months were classified as not exclusively breastfeeding at 3 months. The analysis was restricted to respondents whose infants were 3 months of age or older.

Maternity care practices. Respondents who ever breastfed and whose infant was born in a hospital were instructed to complete the maternity care practice items in response to the statement ''This question asks about things that may have happened at the hospital where your new baby was

born.'' Maternity care practice items were categorized as yes–no. PRAMS includes nine maternity care practice indicators that correspond with some elements of the *Ten Steps* and were examined in this analysis (Table 1).

Exposure to Hurricanes Irma and Maria. To examine exposure to the hurricanes, we classified respondents into four mutually exclusive hurricane exposure time periods based on infant birth month and year relative to when the hurricanes occurred (September 2017) (Supplementary Table S1):

(1) Prehurricane: included births occurring before the hurricanes during March 2017 to May 2017 (first available PRAMS data in Puerto Rico).
(2) Acute hurricane: included births during June 2017 to February 2018. These respondents were classified as having acute hurricane exposure as they were either later in their pregnancy (second/third trimester), up to 3 months postpartum, or gave birth within 6 months (September 2017 to February 2018) of the hurricanes occurring. This approach was used as decisions around breastfeeding intentions, maternity care practices, and breastfeeding practices (i.e., exclusive breastfeeding at 3 months) may have been impacted by the hurricanes or the immediate aftermath of the hurricanes. PRAMS operations were temporarily paused from November to December 2017; therefore, data for these births are not included.
(3) Posthurricane, early recovery: included births during March 2018 to September 2018. These respondents were classified as posthurricane early recovery exposure as they had given birth 6–12 months after the hurricanes occurred, and major infrastructures were restored during this time, such as water systems, power, traffic, permanent reconstruction initiated.[1]
(4) Posthurricane, long-term recovery: included births during October 2018 to December 2019. These respondents were classified as late recovery exposure as they had given birth more than 12 months after the hurricanes occurred and recovery was ongoing.[2–5]

Covariates. Covariates were selected a priori based on previous research examining associations between specific maternity care practices and breastfeeding outcomes.[30,31] Analyses were adjusted for respondent age (<20, 20–24, 25–34, ≥35 years), education (≤high school diploma or general equivalency diploma [GED], some college/associate's degree, ≥bachelor's degree), prenatal participation in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC; yes, no), parity (no previous live births, ≥one previous live births), plurality (singleton, twins/other multiples), and delivery method (vaginal, cesarean). We also adjusted for infant gestational age at delivery (<32, 32–36, ≥37 weeks) and infant length of hospital stay (standard stay for delivery [<1–5 days], exceeds standard stay for delivery).

Table 1. Comparison of the Ten Steps to Successful Breastfeeding and Indicators from the Pregnancy Risk Assessment Monitoring System Maternity Care Practices Question

Ten Steps to Successful Breastfeeding[a]	*Corresponding indicator from PRAMS maternity care practices question*
''1a. Comply fully with the *International Code of Marketing of Breast-Milk Substitutes* and relevant World Health Assembly Resolutions 1b. Have a written infant feeding policy that is routinely communicated to staff and parents. 1c. Establish ongoing monitoring and data-management systems.''	''The hospital gave me a gift pack with formula''[b]
''2. Ensure that staff have sufficient knowledge, competence and skills to support breastfeeding.''	
''3. Discuss the importance and management of breastfeeding with pregnant women and their families.''	
''4. Facilitate immediate and uninterrupted skin-to-skin contact and support mothers to initiate breastfeeding as soon as possible after birth.''	''I breastfed in the first hour after my baby was born''
	''My baby was placed in skin-to-skin contact within the first hour of life''
''5. Support mothers to initiate and maintain breastfeeding and manage common difficulties.''	''Hospital staff helped me learn how to breastfeed''
''6. Do not provide breastfed newborns any food or fluids other than breast milk, unless medically indicated.''	''My baby was fed only breast milk at the hospital''
''7. Enable mothers and their infants to remain together and to practice rooming-in 24 hours a day.''	''My baby stayed in the same room with me at the hospital''
''8. Support mothers to recognize and respond to their infants' cues for feeding''	''Hospital staff told me to breastfeed whenever my baby wanted''
''9. Counsel mothers on the use and risks of feeding bottles, artificial nipples (teats) and pacifiers.''	''Hospital staff gave my baby a pacifier''
''10. Coordinate discharge so that parents and their infants have timely access to ongoing support and care.''	''The hospital gave me a telephone number to call for help with breastfeeding''

[a]Source: https://www.who.int/teams/nutrition-and-food-safety/food-and-nutrition-actions-in-health-systems/ten-steps-to-successful-breastfeeding; https://www.babyfriendlyusa.org/for-facilities/practice-guidelines/10-steps-and-international-code
[b]Provisions in the International Code of Marketing of Breast-Milk Substitutes prevent hospitals from providing free samples of infant formula to families.
PRAMS, Pregnancy Risk Assessment Monitoring System.

Infant length of hospital stay was obtained from PRAMS survey data. All other covariates were obtained from birth certificate data available in the PRAMS dataset.

Statistical analyses

Our analytic sample excluded women whose infants were deceased or not living with them at time of survey completion ($n=47$), those whose infants were not born in a hospital ($n=21$), and women who did not initiate breastfeeding ($n=182$). After excluding those with missing data on covariates ($n=40$) and those who returned the survey before 3 months ($n=130$) or were missing data (not mutually exclusive) on exclusive breastfeeding at 3 months ($n=68$) and maternity care practices ($n=115$), our final analytic sample included 2,448 respondents.

We calculated weighted percentages and 95% confidence intervals (CIs) to describe covariates and the hurricane exposure groups in the overall sample. We also described exclusive breastfeeding at 3 months and the nine maternity care practices in the overall sample and by hurricane exposure time period. We constructed separate multivariable logistic regression models to examine the associations between each maternity care practice (except for infant fed only breast milk in the hospital as our outcome was exclusively breastfeeding) and exclusive breastfeeding at 3 months. The reference group for these models was respondents who did not report the maternity care practice. We also wanted to examine the association between each maternity care practice and exclusive breastfeeding at 3 months, stratified by hurricane exposure time period.

Therefore, we constructed separate models, which examined the associations between the respective maternity care practice being examined and exclusive breastfeeding at 3 months, stratified by hurricane exposure time period: (1) prehurricane; (2) acute hurricane; (3) posthurricane, early recovery; and (4) posthurricane, long-term recovery. The reference group for these models was respondents who did not report the maternity care practice. Finally, we constructed separate models to examine the associations between each outcome (i.e., exclusive breastfeeding at 3 months and each maternity care practice) with hurricane exposure time period. The reference group for these models was the prehurricane time period. All models were adjusted for all previously mentioned covariates.

Data were weighted for survey design, noncoverage, and nonresponse to be representative of all live births in Puerto Rico during the study period. All analyses were completed in SAS 9.4 (SAS Institute, Cary, NC) and SAS Callable SUDAAN 11.0.1 (RTI International, Research Triangle Park, NC) to account for the complex sampling design of PRAMS. The PRAMS protocol was reviewed and approved by CDC's Institutional Review Board (IRB) and University of Puerto Rico Medical Sciences Campus IRB.

Results

Distribution of respondents by covariates and hurricane exposure time period

Overall, most respondents reported prenatal WIC participation (83.6%). More than half of respondents had completed ≥some college (66.0%), were aged ≥25 years (60.8%), had delivered vaginally (57.0%), and had ≥1 previous live birth (51.3%). Most had infants who were singleton (99.0%), were born at ≥37 weeks gestation (90.2%), and had a standard hospital stay for delivery (87.3%). By hurricane exposure time period, 9.9% of respondents were in the prehurricane time period (March 2017 to May 2017 births), 23.8% were in the acute hurricane time period (June 2017 to February 2018 births), 21.2% were in the posthurricane, early recovery time period (March 2018 to September 2018 births), and 45.1% were in the posthurricane, long-term recovery time period (October 2018 to December 2019 births) (Table 2).

Overall prevalence of exclusive breastfeeding at 3 months and maternity care practices

Overall, 31.3% of respondents who started breastfeeding reported exclusively breastfeeding at 3 months (Table 3). During delivery hospitalization, approximately three-fourths of respondents reported the following maternity care practices: rooming-in with their infant (76.9%), skin-to-skin contact in the first hour of life (75.8%), being told by hospital staff to breastfeed whenever their infant wanted (75.0%), and receiving help learning to breastfeed from hospital staff (73.8%). Approximately half of respondents breastfed in the first hour after their infant was born (56.1%). Nearly half of respondents were given a telephone number to call for questions about breastfeeding by hospital staff (49.4%), only fed their infant breast milk in the hospital (47.0%), and received a gift pack with formula from the hospital (45.7%). Fewer respondents reported hospital staff gave their infant a pacifier (12.4%).

Overall association between maternity care practices and exclusive breastfeeding at 3 months

In adjusted analyses, all practices were significantly associated with exclusive breastfeeding at 3 months, except for receiving help from hospital staff to learn how to breastfeed and practicing skin-to-skin contact within the first hour of life. Rooming-in (adjusted prevalence ratio [aPR]: 1.92, 95% CI: 1.47–2.50) had the strongest positive association with exclusive breastfeeding at 3 months, followed by breastfeeding in the first hour after birth (aPR: 1.66, 95% CI: 1.39–1.99). Receiving a gift pack with formula (aPR: 0.38, 95% CI: 0.31–0.46) and infant pacifier receipt (aPR: 0.62, 95% CI: 0.46–0.84) were both negatively associated with exclusive breastfeeding at 3 months (Table 4).

Association between maternity care practices and exclusive breastfeeding at 3 months stratified by hurricane exposure time period

There was variability in the association between maternity care practices on breastfeeding exclusivity at 3 months postpartum when stratified by time period relative to when the hurricanes occurred (Table 4). Receipt of a gift pack with formula was negatively associated with exclusive breastfeeding (aPR range: 0.22–0.54) across all time periods. Breastfeeding in the first hour (aPR range: 1.51–1.92) and rooming-in (aPR range: 1.50–2.58) were positively associated with exclusive breastfeeding across all time periods, except the prehurricane time period. Hospital staff helping respondents learn how to breastfeed was positively

Table 2. Distribution of Respondents by Covariates and Exposure to Hurricanes Irma and Maria[a] Among Respondents Who Started Breastfeeding: Pregnancy Risk Assessment Monitoring System, Puerto Rico 2017–2019

Covariates[b]	*Overall, N = 2,448*[c] *% (95% CI)*[d,e]
Maternal age (years)	
<20	8.6 (7.2–10.1)
20–24	30.6 (28.3–32.9)
25–34	48.4 (45.9–50.9)
≥35	12.4 (10.9–14.2)
Education	
≤High school diploma or GED	34.0 (31.7–36.4)
Some college or associate's degree	32.6 (30.3–34.9)
≥Bachelor's degree	33.4 (31.1–35.8)
Prenatal participation in WIC	
Yes	83.6 (81.6–85.5)
No	16.4 (14.5–18.4)
Parity	
No previous live births	48.7 (46.2–51.2)
≥1 previous live births	51.3 (48.8–53.8)
Plurality	
Singleton	99.0 (98.6–99.2)
Twins or other multiples	1.0 (0.8–1.4)
Delivery method	
Vaginal	57.0 (54.6–59.5)
Cesarean	43.0 (40.5–45.4)
Infant gestational age at delivery (weeks)	
<32	1.0 (0.9–1.2)
32–36	8.7 (7.7–9.9)
≥37	90.2 (89.1–91.3)
Infant length of hospital stay[b]	
Standard stay for delivery, <1–5 days	87.3 (85.8–88.6)
Exceeds standard stay for delivery	12.7 (11.4–14.2)
Exposure to Hurricanes Irma and Maria	
Prehurricane, no exposure (March 2017 to May 2017 births)	9.9 (8.7–11.1)
Acute hurricane exposure (June 2017 to February 2018 births)[f]	23.8 (22.2–25.6)
Posthurricane, early recovery (March 2018 to September 2018 births)	21.2 (19.5–23.0)
Posthurricane, long-term recovery (October 2018 to December 2019 births)	45.1 (43.4–46.8)

[a]We classified respondents into four separate exposure groups based on infant birth month and year relative to when the hurricanes occurred (September 2017).
[b]Infant length of hospital stay was obtained from the PRAMS survey data. All other covariates were obtained from birth certificate data available in the PRAMS dataset.
[c]Unweighted sample size.
[d]Weighted percentage (95% CI).
[e]Values might not sum to 100% due to rounding.
[f]PRAMS was temporarily paused from November to December 2017, therefore, data for these births were unavailable.
CI, confidence interval; GED, general equivalency diploma; PRAMS, Pregnancy Risk Assessment Monitoring System; WIC, the Special Supplemental Nutrition Program for Women, Infants, and Children.

associated with breastfeeding among the acute hurricane time period only (aPR: 1.40). Hospital staff giving respondents a telephone number to call for help with breastfeeding was positively associated with breastfeeding among the posthurricane, early recovery time period only (aPR: 2.05). Giving infants a pacifier to use was negatively associated with breastfeeding among the posthurricane, long-term recovery time period only (aPR: 0.52).

Associations between each outcome (i.e., exclusive breastfeeding at 3 months and each maternity care practice) with hurricane exposure time period

In adjusted analyses, compared with the prehurricane time period, exclusive breastfeeding at 3 months was higher among the acute hurricane time period (aPR: 1.43, 95% CI: 1.09–1.87) (Table 5). Differences in maternity care practices were also observed for infant pacifier receipt. Compared with the prehurricane time period, infant pacifier receipt was lower among the acute hurricane time period (aPR: 0.57, 95% CI: 0.39–0.84), the posthurricane, early recovery time period (aPR: 0.62, 95% CI: 0.41–0.93), and the posthurricane, long-term recovery time period (aPR: 0.65, 95% CI: 0.46–0.92). For all other maternity care practices, no differences were observed between the prehurricane time period and other time periods.

Discussion

Overall, maternity care practices we examined have associations in the expected direction: breastfeeding in the first hour after their infant was born, rooming-in with their infant, being told by hospital staff to breastfeed whenever their infant wanted, and being given a telephone number to call for help with breastfeeding were positively associated with exclusive breastfeeding at 3 months, and being given a gift pack with formula and hospital staff giving infants a pacifier were negatively associated with exclusive breastfeeding at 3 months. However, the association between each practice and exclusive breastfeeding at 3 months varied when stratifying by hurricane exposure time period.

These findings suggest that maternity care practices that support breastfeeding (e.g., initiation of breastfeeding in the first hour after delivery and rooming-in) are important to promote, whereas practices that adversely affect breastfeeding (e.g., providing a gift pack with formula) are important to discontinue. Maternity care practices that support breastfeeding are especially important to consider during and after natural disasters or other public health emergencies when access to other forms of breastfeeding support might be interrupted or limited.[32,33] For example, in Puerto Rico, following Hurricanes Irma and Maria, WIC services where women might receive breastfeeding support were closed for several weeks.[34]

Exclusive breastfeeding at 3 months was higher among the acute hurricane time period than the prehurricane time period. This finding might be owing to other study findings such as the significant association between several maternity care practices and exclusive breastfeeding in the acute hurricane time period versus only one maternity care practice associated with exclusive breastfeeding in the prehurricane time period. Furthermore, hospital staff helping respondents learn to breastfeed was positively associated with exclusive

Table 3. Overall Prevalence of Exclusive Breastfeeding at 3 Months, and Maternity Care Practices Overall and by Timing of Exposure to Hurricanes Irma and Maria,[a] Among Respondents Who Started Breastfeeding: Pregnancy Risk Assessment Monitoring System, Puerto Rico 2017–2019

	Timing of exposure to Hurricanes Irma and Maria by infant birth month and year, % (95% CI)[b]				
	Overall, N = *2,448*[c]	*Prehurricane (March 2017 to May 2017 births),* n = *289*[c]	*Acute hurricane (June 2017 to February 2018 births),*[d] n = *647*[c]	*Posthurricane, early recovery (March 2018 to September 2018 births),* n = *446*[c]	*Posthurricane, long-term recovery (October 2018 to December 2019 births),* n = *1,066*[c]
Exclusive breastfeeding at 3 months[e]	31.3 (29.0–33.6)	25.3 (19.6–32.1)	35.0 (30.5–39.8)	30.7 (25.6–36.4)	30.8 (27.4–34.4)
Maternity care practices					
The hospital gave me a gift pack with formula	45.7 (43.2–48.2)	44.8 (37.7–52.1)	39.3 (34.6–44.1)	44.3 (38.7–50.1)	49.9 (46.1–53.6)
I breastfed in the first hour after my baby was born	56.1 (53.6–58.5)	59.5 (52.3–66.4)	55.0 (50.2–59.8)	56.5 (50.7–62.1)	55.7 (51.9–59.3)
My baby was placed in skin-to-skin contact within the first hour of life	75.8 (73.7–77.8)	77.0 (70.6–82.3)	74.4 (70.0–78.3)	76.4 (71.2–80.8)	76.0 (72.8–79.0)
Hospital staff helped me learn how to breastfeed	73.8 (71.6–76.0)	76.9 (70.3–82.4)	75.3 (70.9–79.2)	74.8 (69.5–79.5)	71.9 (68.5–75.2)
My baby was fed only breast milk at the hospital	47.0 (44.5–49.5)	48.4 (41.2–55.6)	45.1 (40.3–50.0)	48.1 (42.3–53.9)	47.1 (43.4–50.9)
My baby stayed in the same room with me at the hospital	76.9 (74.8–78.8)	74.7 (68.1–80.4)	72.5 (68.1–76.5)	75.7 (70.8–80.1)	80.2 (77.3–82.8)
Hospital staff told me to breastfeed whenever my baby wanted	75.0 (72.8–77.1)	73.5 (66.6–79.3)	71.0 (66.3–75.2)	76.2 (70.9–80.8)	76.9 (73.7–79.9)
Hospital staff gave my baby a pacifier	12.4 (10.9–14.0)	18.3 (13.4–24.6)	10.6 (8.0–13.8)	11.7 (8.5–15.8)	12.3 (10.2–14.9)
The hospital gave me a telephone number to call for help with breastfeeding	49.4 (46.9–51.9)	47.8 (40.6–55.0)	44.1 (39.4–49.0)	52.8 (47.0–58.6)	50.9 (47.1–54.6)

[a]We classified respondents into four separate exposure groups based on infant birth month and year relative to when the hurricanes occurred (September 2017).
[b]Weighted percentage (95% CI).
[c]Unweighted sample size.
[d]PRAMS was temporarily paused from November to December 2017, therefore, data for these births were unavailable.
[e]Exclusive breastfeeding is defined as the infant having received only breast milk with no other liquids or solid foods.[7]
CI, confidence interval; PRAMS, Pregnancy Risk Assessment Monitoring System.

breastfeeding at 3 months among respondents in the acute hurricane time period only. There was also a decline in pacifier receipt between time periods. Other factors might have also played a role in this finding that we were not able to assess with PRAMS data.

For example, several initiatives were implemented in Puerto Rico following the hurricanes to support breastfeeding, such as the ''Water for Milk'' initiative, which provided access to a safe source of drinking water to pregnant and postpartum women through distribution of water filters.[2] Furthermore, respondents' desire to breastfeed might have differed between hurricane exposure groups and influenced their decision to exclusively breastfeed and continue breastfeeding.

Our findings demonstrated no difference in receiving most maternity care practices regardless of exposure to the hurricanes, suggesting that hospitals were resilient in providing and improving maternity care practices in the aftermath of the hurricanes (i.e., less pacifier receipt). There might be additional opportunities to improve maternity care practices in hospitals. The proportion of those reporting practices that support breastfeeding ranged from 49% reporting they received a telephone number to 77% reporting rooming-in. Furthermore, 12% of respondents reported pacifier receipt and 46% reported receipt of a gift pack with formula, both practices that are known to be negatively associated with exclusive breastfeeding at 3 months. Findings from our analysis could be used to help inform efforts to identify opportunities to improve maternity care practices in general, and in the context of public health emergencies.

Limitations

There are several limitations to our findings. First, PRAMS data are self-reported and subject to recall and social desirability bias. Our analysis was also limited to respondents who

Table 4. Association Between Maternity Care Practices and Exclusive Breastfeeding at 3 Months[a] Overall and Stratified by Timing of Exposure to Hurricanes Irma and Maria[b] Among Respondents Who Started Breastfeeding: Pregnancy Risk Assessment Monitoring System, Puerto Rico 2017–2019

		Timing of exposure to Hurricanes Irma and Maria by infant birth month and year, aPR (95% CI)[c,d]			
	Overall, n = *2,448*[e]	*Prehurricane (March 2017 to May 2017 births),* n = *289*[e]	*Acute hurricane (June 2017 to February 2018 births),*[f] n = *647*[e]	*Posthurricane, early recovery (March 2018 to September 2018 births),* n = *446*[e]	*Posthurricane, long-term recovery (October 2018 to December 2019 births),* n = *1,066*[e]
Maternity care practices					
The hospital gave me a gift pack with formula	**0.38 (0.31–0.46)**	**0.54 (0.31–0.93)**	**0.30 (0.20–0.45)**	**0.22 (0.12–0.38)**	**0.48 (0.37–0.61)**
I breastfed in the first hour after my baby was born	**1.66 (1.39–1.99)**	1.27 (0.76–2.12)	**1.92 (1.43–2.59)**	**1.92 (1.26–2.94)**	**1.51 (1.17–1.95)**
My baby was placed in skin-to-skin contact within the first hour of life	1.08 (0.88–1.32)	1.04 (0.58–1.89)	1.30 (0.93–1.83)	1.36 (0.84–2.21)	0.89 (0.68–1.17)
Hospital staff helped me learn how to breastfeed	1.19 (1.00–1.42)	1.00 (0.57–1.75)	**1.40 (1.01–1.96)**	1.09 (0.73–1.63)	1.17 (0.90–1.53)
My baby stayed in the same room with me at the hospital	**1.92 (1.47–2.50)**	1.43 (0.77–2.66)	**1.50 (1.03–2.17)**	**2.58 (1.43–4.68)**	**2.39 (1.58–3.60)**
Hospital staff told me to breastfeed whenever my baby wanted	**1.31 (1.08–1.58)**	1.42 (0.79–2.53)	1.36 (0.99–1.87)	1.49 (0.93–2.41)	1.20 (0.89–1.62)
Hospital staff gave my baby a pacifier	**0.62 (0.46–0.84)**	0.94 (0.50–1.75)	0.80 (0.49–1.30)	0.51 (0.23–1.13)	**0.52 (0.32–0.87)**
The hospital gave me a telephone number to call for help with breastfeeding	**1.21 (1.05–1.40)**	1.15 (0.71–1.86)	1.18 (0.92–1.52)	**2.05 (1.39–3.03)**	1.01 (0.80–1.27)

Significant associations are given in bold.

[a]Exclusive breastfeeding is defined as the infant having received only breast milk with no other liquids or solid foods.[7]

[b]We classified respondents into four separate exposure groups based on infant birth month and year relative to when the hurricanes occurred (September 2017).

[c]Adjusted for respondent age, education, prenatal participation in WIC, parity, plurality, delivery method, infant gestational age at delivery, and infant length of hospital stay. Infant length of hospital stay was obtained from the PRAMS survey data. All other covariates were obtained from birth certificate data available in the PRAMS dataset. The reference group for each model was respondents who did not report the maternity care practice.

[d]Each model stratified the respective maternity care practice being examined by the exposure group.

[e]Unweighted sample size.

[f]PRAMS was temporarily paused from November to December 2017, therefore, data for these births were unavailable.

aPR, adjusted prevalence ratio; CI, confidence interval; PRAMS, Pregnancy Risk Assessment Monitoring System; WIC, the Special Supplemental Nutrition Program for Women, Infants, and Children.

returned the survey after 3 months. Second, PRAMS data collection in Puerto Rico was temporarily paused during Hurricanes Irma and Maria and, as a result, no data on maternity care practices or breastfeeding exclusivity were available for women who gave birth during November to December 2017. Third, our findings were limited to women who had initiated breastfeeding and do not represent women who did not initiate breastfeeding. Fourth, we were unable to examine what other breastfeeding support (e.g., lactation support received after discharge from the hospital) women received, which could have affected breastfeeding. This is notable, as several initiatives were implemented in Puerto Rico following the hurricanes to support breastfeeding.[2]

Fifth, although the PRAMS survey question on maternity care practices captured some, it did not capture all or align exactly with all the practices outlined in the *Ten Steps*. Of note, in Puerto Rico, several policies have been implemented to support breastfeeding over the last two decades, including policies aimed at establishing breastfeeding support programs aligned with the *Ten Steps*.[35,36] However, data available for our analysis on maternity care practices were self-reported by respondents and hospital-level data on maternity care practices were not available in the PRAMS data set.

Finally, our findings are limited to Puerto Rico, potentially limiting the generalizability to other jurisdictions and other emergencies affecting maternal and child health.

Table 5. Association Between Exclusive Breastfeeding at 3 Months or Maternity Care Practices by Time Period Exposure to Hurricanes Irma and Maria[a] Among Respondents Who Started Breastfeeding: Pregnancy Risk Assessment Monitoring System, Puerto Rico 2017–2019

	Timing of exposure to Hurricanes Irma and Maria by infant birth month and year, aPR (95% CI)[b]			
	Prehurricane (March 2017 to May 2017 births),[c] n = *289*[d]	*Acute hurricane (June 2017 to February 2018 births),*[e] n = *647*[d]	*Posthurricane, early recovery (March 2018 to September 2018 births),* n = *446*[d]	*Posthurricane, long-term recovery (October 2018 to December 2019 births),* n = *1,066*[d]
Exclusive breastfeeding at 3 months[f]	1.00	**1.43 (1.09–1.87)**	1.20 (0.90–1.62)	1.22 (0.94–1.60)
Maternity care practices				
The hospital gave me a gift pack with formula	1.00	0.86 (0.71–1.06)	0.99 (0.81–1.22)	1.10 (0.92–1.32)
I breastfed in the first hour after my baby was born	1.00	0.96 (0.84–1.10)	0.94 (0.82–1.09)	0.95 (0.84–1.08)
My baby was placed in skin-to-skin contact within the first hour of life	1.00	0.99 (0.91–1.07)	0.99 (0.90–1.08)	1.00 (0.92–1.08)
Hospital staff helped me learn how to breastfeed	1.00	0.98 (0.89–1.07)	0.97 (0.88–1.08)	0.93 (0.85–1.02)
My baby stayed in the same room with me at the hospital	1.00	0.98 (0.89–1.08)	1.03 (0.93–1.13)	1.09 (1.00–1.19)
Hospital staff told me to breastfeed whenever my baby wanted	1.00	0.97 (0.87–1.08)	1.04 (0.93–1.16)	1.05 (0.95–1.16)
Hospital staff gave my baby a pacifier	1.00	**0.57 (0.39–0.84)**	**0.62 (0.41–0.93)**	**0.65 (0.46–0.92)**
The hospital gave me a telephone number to call for help with breastfeeding	1.00	0.92 (0.77–1.11)	1.10 (0.92–1.33)	1.06 (0.90–1.25)

Significant associations are given in bold.

[a]We classified respondents into four separate exposure groups based on infant birth month and year relative to when the hurricanes occurred (September 2017).

[b]Adjusted for respondent age, education, prenatal participation in WIC, parity, plurality, delivery method, infant gestational age at delivery, and infant length of hospital stay. Infant length of hospital stay was obtained from the PRAMS survey data. All other covariates were obtained from birth certificate data available in the PRAMS dataset.

[c]The reference group for each model was respondents in the prehurricane, no exposure (March 2017 to May 2017 births) group.

[d]Unweighted sample size.

[e]PRAMS was temporarily paused from November to December 2017, therefore, data for these births were unavailable.

[f]Exclusive breastfeeding is defined as the infant having received only breast milk with no other liquids or solid foods.[7]

aPR, adjusted prevalence ratio; CI, confidence interval; PRAMS, Pregnancy Risk Assessment Monitoring System; WIC, the Special Supplemental Nutrition Program for Women, Infants, and Children.

Despite these limitations, our findings provide insight into the relationship between maternity care practices and exclusive breastfeeding at 3 months before and after a natural disaster.

Conclusion

Breastfeeding is the safest option to provide infant nutrition during a natural disaster and other public health emergencies.[8] Implementing maternity care practices supportive of breastfeeding and discontinuing practices that discourage breastfeeding can improve breastfeeding rates.[21] Other strategies to support infant feeding during emergencies are outlined in CDC's Infant and Young Child Feeding in Emergencies Toolkit.[8]

We found maternity care practices supportive of breastfeeding were positively associated with exclusively breastfeeding at 3 months, and practices that are risk factors for discontinuing breastfeeding were negatively associated with exclusive breastfeeding at 3 months. Implementation of maternity care practices supportive of breastfeeding during delivery hospitalization and discontinuation of practices that discourage breastfeeding, when feasible, can be important to support exclusive breastfeeding during and after natural disasters. Strategies to maintain and improve these practices can be further supported during natural disasters or other public health emergencies when access to other forms of breastfeeding support might be interrupted or limited.

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Authors' Contributions

K.K. conceptualized the study, conducted the analyses, interpreted the data, and drafted and revised the article. B.S.E., E.A., S.E., W.H.V., D.V.D., P.S., I.M.O., M.V.B., and L.W. contributed to the study design, assisted with data interpretation, and reviewed and revised the article. All authors approved the final version of the article as submitted and agree to be accountable for all aspects of the work.

Disclaimer

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the CDC.

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Supplementary Material

Supplementary Table S1

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