Published in final edited form as:
Matern Child Health J. 2010 July ; 14(4): 511–518. doi:10.1007/s10995-009-0486-x.

Hurricane Katrina-related maternal stress, maternal mental health, and early infant temperament

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Abstract

To investigate temperament in infants whose mothers were exposed to Hurricane Katrina and its aftermath, and to determine if high hurricane exposure is associated with difficult infant temperament. A prospective cohort study of women giving birth in New Orleans and Baton Rouge, LA (n=288) in 2006–2007 was conducted. Questionnaires and interviews assessed the mother's experiences during the hurricane, living conditions, and psychological symptoms, two months and 12 months postpartum. Infant temperament characteristics were reported by the mother using the activity, adaptability, approach, intensity, and mood scales of the Early Infant and Toddler Temperament Questionnaires, and "difficult temperament" was defined as scoring in the top quartile for three or more of the scales. Logistic regression was used to examine the association between hurricane experience, mental health, and infant temperament. Serious experiences of the hurricane did not strongly increase the risk of difficult infant temperament (association with 3 or more serious experiences of the hurricane: adjusted odds ratio (aOR) 1.50, 95% confidence interval (CI) 0.63–3.58 at 2 months; 0.58, 0.15–2.28 at 12 months). Maternal mental health was associated with report of difficult infant temperament, with women more likely to report having a difficult infant temperament at one year if they had screened positive for PTSD (aOR 1.82, 95% confidence interval (CI) 0.61–5.41), depression, (aOR 3.16, 95% CI 1.22–8.20) or hostility (aOR 2.17, 95% CI 0.81–5.82) at 2 months. Large associations between maternal stress due to a natural disaster and infant temperament were not seen, but maternal mental health was associated with reporting difficult temperament. Further research is needed to determine the

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Conflicts of interest statement

All authors participated in the design, execution, and analysis of the paper, have seen and approved the final version, and have no actual conflicts of interest or potential conflicts of interest.

effects of maternal exposure to disasters on child temperament, but in order to help babies born in the aftermath of disaster, the focus may need to be on the mother's mental health.

Keywords

infant temperament; natural disaster; postpartum depression; post-traumatic stress disorder

Introduction

A traumatic event, such as a terrorist attack or natural disaster, exposes individuals to intense and varying degrees of stress. (1) Hurricane Katrina made landfall on August 29, 2005, in the Gulf Coast region of the United States. The hurricane caused extensive damage to the city of New Orleans, and subsequent levee failure caused over 80% of the city to flood. Hurricane Katrina is now considered the costliest and one of the five deadliest storms to hit the United States.(2) The storm damage, flooding, and the slow response to needs thereafter, produced substantial psychological harm to many. (3)

Research on humans and animals indicates that psychosocial and physiological stressors during pregnancy are associated with changes in behavioral, cognitive, and physiologic infant outcomes. (4–6) In one study, pregnant mothers who perceived themselves as stressed produced infants with more difficult behavior, and anxious pregnant women had infants with poor attention regulation during the first year of life. (7) These children had increased restlessness, behavior problems, and attention regulation problems at two years of age. (8) A large, prospective cohort found that mothers who experienced high levels of anxiety during late pregnancy had infants with higher rates of hyperactivity, emotionality, and conduct problems . (9) Chronic stress and anxiety during pregnancy has been associated with difficult temperament, poorer behavioral maturity, and increased irritability in newborns. (10, 11) Women who experienced the effects of a severe ice storm in the first or second trimester of the pregnancy had infants with reduced mental development indices and language skills at two years, as well as a shift from relational to functional play. Exposure in the third trimester was associated with reduced language skills, but no change on other indices.(12) Biologically, higher levels of the stress hormones cortisol and corticotrophin have been associated with poor regulation of stress and increased fear behavior in infants. (13, 14)

Infant temperament encompasses various personality aspects and individual differences in behavior. In the longest and most comprehensive longitudinal study assessing infant temperament, Thomas and Chess found certain characteristics (activity level, rhythmicity, approach/withdrawal, adaptability, intensity of reactions, responsiveness, mood, distractibility, and attention span) to be predictive of subsequent behavioral disorders at an older age. (15)

The objective of this study was to examine temperament in a group of infants whose mothers were exposed to Hurricane Katrina and its aftermath. We hypothesized that the high level of maternal stress would lead to changes in temperament detectable in infancy.

Methods

Subjects

This prospective cohort recruited women giving birth between February 2006 and May 2007 at either Tulane-Lakeside Hospital in Metairie, LA or Woman's Hospital in Baton Rouge, LA. Both hospitals serve a wide selection of their respective metro areas. Women were

excluded from the study if they were under 18, could not communicate in English, or did not have access to a telephone. The New Orleans area group needed to have lived in the area before Hurricane Katrina. Subjects recruited in Baton Rouge were excluded if they had lost a family member due to the hurricane or if they had evacuated Baton Rouge during Hurricane Katrina or Rita; there were no other exclusions. Our rationale for the study design was to compare the group from New Orleans that had been exposed to Katrina and the group from Baton Rouge that had not been extensively exposed to Katrina. However, when we analyzed our data, we found the range of experience was more extensive within the groups than between them, so they are grouped for analysis purposes.

365 women were recruited for the study. 292 (80%) completed an interview at 8–10 weeks postpartum. Thirty-seven women had either incomplete 8-week questionnaires or were interviewed at an incorrect infant age (infant was older than four and a half months or less than one month old). 171 women completed the temperament questionnaire at one year. 288 women had valid information on infant temperament at either 2 or 12 months. The dropout subjects were more likely to be younger and in the lower socioeconomic group.

Institutional Review Boards at both institutions approved the study and all participants provided written informed consent.

Maternal stress measurement

Shortly after delivery, the mother was interviewed by a research assistant. The delivery questionnaire provided basic demographic information as well as information on hurricane stress exposure and social support. Participants were asked a series of yes-no response questions on various hurricane-related stressors. Hurricane experience was based on answers to nine questions, including whether the participant ever felt her life was in danger during the storm, if she or a family member became ill or injured as a result of the storm, if she walked through floodwaters, severity of damage to her home and possessions, if anyone close to her died, or if she witnessed anyone die. These items asked about threat, injury, and loss, which have been shown to be associated with mental health in previous disaster studies. (16–18) The scale was based on a previous study of Hurricane Andrew by Kaniasty and Norris. (19)

The second interview gathered information on living conditions before the storm, at the evacuation locations, and current living conditions. Access to food and water, concern for one’s safety, availability of food, crowding and isolation, and comfort of surroundings were compared to responses on living conditions before the hurricane. Women were classified as having living conditions that were better, worse, or the same. Those having no changes in living conditions were used for comparison to those with changes.

Post-traumatic stress disorder (PTSD) was measured using the PTSD Checklist–Civilian Version screening tool, a series of questions about symptoms of PTSD over the last month. This checklist was originally developed by the National Center for PTSD, using criteria from the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV). PTSD was defined as a score of 3 or more on one reexperiencing, three avoidance, and two hyperarousal criteria. This conforms to the psychiatric definition of PTSD and has been used in other studies. (20) Information on PTSD was gathered at both 8 weeks and one year.

Postpartum depression was measured using the Edinburgh Postnatal Depression (PPD) Scale, a widely used screening questionnaire for this disorder. The Edinburgh scale was found to have sensitivities between 59–100% and specificities between 49–100%, depending on the study population. (21) Subjects in our study were dichotomized into those with a

score less than 12 and those with a score of 12 or higher. A woman scoring 12 or higher was classified as screening positive for PPD.

The Symptoms Checklist-90-Revised was used to identify participants with symptoms of somatization, obsessive-compulsive tendencies, hostility, and anxiety. This checklist is used worldwide as a multi-dimensional self-assessment tool, and has internal consistencies measured by Cronbach's α between 0.75 and 0.97 for the four symptoms assessed. (22) Women in our study were dichotomized into exhibiting symptoms of the outcome or not exhibiting the symptoms. A symptom was classified as present if the score from the questionnaire responses was above the 90^{th} percentile of a nonclinical female population.

Infant temperament measurement

Women were interviewed about the temperament of their infants using the Early Infant Temperament Questionnaire (EITQ). The EITQ was designed to assess behavior characteristics between one and four months of age. (23) The Early Infant Temperament Questionnaire was modeled after the Revised Infant Temperament Questionnaire, designed to analyze a child on the nine characteristics of temperament identified by Thomas and Chess. (24) The Toddler Temperament Questionnaire, a similar instrument with questions appropriate for 1 to 2 1/2 –year-olds, was used to examine temperament at one year.

A shortened version of the EITQ was used in this study. This shortened version was also used in the National Institute of Child Health and Human Development (NICHD) Study of Early Child Care and Youth Development. (25) Five constellations of infant temperament assessed in the NICHD study were also used in this study: activity, approach, adaptability, intensity and mood. (Supplementary table 1 describes the relationships among the aspects of infant temperament.) In the development of the survey, the internal consistency for these subscales at 1–2 months were 0.48, 0.44, 0.65, 0.43, and 0.70, respectively, while the retest reliability was 0.62, 0.48, 0.80, 0.59, and 0.72. At 3–4 months, the corresponding values were 0.58, 0.63, 0.65, 0.43, and 0.68, while retest reliabilities were 0.80, 0.87, 0.81, 0.61, and 0.77. (23) The same constellations of infant temperament were asked again on the one-year questionnaire.

A numerical score, ranging from 1 to 6, was generated for each question of the EITQ and TTQ. After reverse coding was accounted for, an individual mean score for each of the five characteristics of infant temperament assessed in this study was calculated, with higher scores indicating an infant is more difficult or temperamental. For example, a score higher than the mean for adaptability would indicate an infant was less adaptable compared to his/her infant peers. If an infant had a mean score greater than 75% of our study population for one of the five characteristics, the child was classified as being difficult for that particular characteristic. In order to create a summary variable, difficult temperament was defined as having three or more difficult characteristics. Data were also analyzed defining "difficult temperament" as having two or more difficult characteristics, considering each temperamental scale as a continuous variable, and using cutoffs for "difficult" from the published norms instead of the study population; results were very similar.

Statistical analysis

Data was analyzed using the SAS 9.13 for Windows statistical package. Associations between difficult temperament and hurricane-related stressors, living conditions during evacuation, and mental health were analyzed. Logistic regression was performed to calculate odds ratios (OR) and to calculate 95% confidence intervals (CI). All analyses were adjusted for infant's age at the time of the interview. Multivariable logistic regression was used to adjust for the following potential confounders: mother's age, income level (reduced from a

9-level multiple choice), marital status, smoking status prior to pregnancy, and parity. Covariates were analyzed in the form listed in table 2 (except age, which was kept continuous).

Median time between Katrina and delivery was 43.4 weeks, with a range from 22.6 to 89.3. A total of 68 (24%) women included in this analysis were pregnant when Hurricane Katrina made landfall, while 216 (76%) women became pregnant later. Results were examined within these strata to see if they differed.

Results

Ages of the mothers at childbirth ranged from 18 to 43 years old, with a median and mean age of 29 years. Caucasian women represented 67% of the included participants, with African-Americans representing 29% (Table 1). Nearly all women were exposed to specific hurricane-related stressors based on questionnaire responses, with 18% of women exposed to three or more stressors. Only 7% of women in this study screened positive for post-traumatic stress disorder, while 24% screened positive for postpartum depression.

Infant temperament measures were significantly correlated with each other (supplementary material) at each time point. Across the two time points, some dimensions of temperament were correlated, but not others. Most strongly correlated was adaptability ($r=0.31$, $p<0.01$) and mood ($r=0.30$, $p<0.01$), while intensity was uncorrelated ($r=-0.01$, $p=0.88$). However, the correlations were all fair to low. 30% of those reported as difficult for the first visit were reported difficult at the second visit, while 16% of those not reported as difficult for the first visit were reported difficult at the second visit.

For the most part, serious experience of the hurricane did not strongly increase the odds of an infant displaying ≥ 3 difficult temperament characteristics (Table 2). Odds ratios were raised for fearing for one's life, walking through flood water, seeing someone die, and changes in living situations, but results were not consistent or strong. The summary measure of severe experience was not associated with poor temperament. Likewise, few differences in the individual continuous temperament scores were seen by hurricane experience.

Maternal mental health was associated with infant temperament (Table 3). Women who screened positive for PTSD, postpartum depression, and hostility had increased odds of reporting having infants with ≥ 3 difficult temperament characteristics at 2 months, and women who screened positive for any mental health problem except somatization at 2 months or any mental health problem at 12 months had an increased odds of difficult temperament at 12 months. Poor maternal mental health was associated with certain individual temperament scales; PTSD was most associated with adaptability and intensity, depression with adaptability and mood, anxiety with activity and intensity, hostility with adaptability, mood, and intensity, and OCD with intensity and mood.

We assessed whether these results differed by whether the woman was pregnant during the hurricane or only after the storm. The small sample size pregnant during the storm makes comparisons difficult, but generally no statistical difference was seen between the groups. No interaction was seen for any mental health predictor, or for infant temperament at two months. Interaction was seen for a small number of hurricane variables predicting temperament at 12 months; for instance, flooding in the house was not associated with temperament among those not pregnant during the storm (OR 0.64, 95% CI 0.24–1.69), while it was strongly associated among those pregnant during the storm (OR 11.25, 95% CI 2.11–59.88).

Discussion

This study analyzed the effects of maternal stress related to Hurricane Katrina on reported infant temperament. Overall, hurricane stress did not have major effects on infant temperament. However, women with high scores on many mental health scales reported more difficult infants. The one major previous study on effects of disaster analyzed women pregnant during a major ice storm; their children had poorer intellectual and language functioning at two years of age.(12, 26) Our results may be different due to the timing of the research or the focus on temperament rather than cognitive development. Further research is needed to fully assess the effects of event-related maternal stress on a developing child. Previous studies indicate maternal stress increases the activity level of an infant, (7, 8, 27) and any alteration of the normal and familiar environment may be stressful enough to induce the biophysical changes in the mother that affect infant growth and neuro-endocrine systems. (28, 29)

The association with maternal mental health is consistent with many previous studies. Research has consistently demonstrated an association between depression of the mother and difficult infant emotion regulation, increased lability, and decreased affect. (30) One meta-analysis specifically showed a significant relationship between postpartum depression and altered infant temperament. (31) Another study indicated that mothers with hostility associated with postpartum depression had infants with difficult temperament. (32) Other research found that women with anger and a co-morbid depression during pregnancy were more likely to have infants that had less autonomic stability and were more withdrawn .(33, 34) It is likely that the relationship between maternal mental health and infant temperament is a combination of mothers' perceiving their child more negatively, a negative temperament contributing to mental illness in the mother, shared genetic and environmental vulnerability, and direct influences of the mother's mental health on the child's temperament. Effects of postpartum depression may also be related to prenatal and perinatal depression that carries through the birth of the child. This information was not available for our study.

Strengths of this study include assessing the topic in a community-based group, systematic recruitment of participants, and the use of validated instruments. However, for the Early Infancy Temperament Questionnaire (EITQ), the means in our study population were consistently lower than the means provided by the EITQ authors.(23) This could be a result of the difference in presentation of the shortened version (35) and the full-length version, or may indicate that cultural or community-wide differences in perception existed in our exclusively southern Louisianan population. Also, our study was limited to English-speaking women. Perhaps the most severe limitation in interpreting the study was the evaluation of infant temperament, which was done by the mother. While the mother could likely assess the temperament of the child best, her perception may be skewed by pre-formed ideas of how an infant should behave. In addition, a woman suffering from depression or PTSD may evaluate her child differently due to her mental state. An objective observer, such as a child psychologist, may be better suited to evaluate a child compared to others of the same age. However, an objective observer may not be able to interact with the infant long enough to make a correct assessment of temperament. Previous research on infant temperament suggests that parental report contains both objective and subjective components, the second colored by the parents' characteristics rather than the child's. (36) This limitation cannot fully be addressed in the current study design, and a follow-up with more extensive child measurements is planned.

Assessment of the stressors occurred several to many months after the storm, and recollection of the events, such as living conditions, could potentially have decreased the validity of responses. Also, the hurricane occurred either during early pregnancy or prior to

conception. Analysis of those women who conceived prior to Katrina's landfall compared to those who conceived after landfall did not reveal major differences between the two groups. For a direct, biological effect of stress hormones, one might expect stronger results in the group that was pregnant during the storm. However, the period of severe stress lasted longer than several days or even several weeks; New Orleans remained flooded for three weeks, and most schools did not re-open until January 2006. Thus, mothers who became pregnant after landfall were still likely exposed to extensive hurricane-related stress. Secondly, the group pregnant during the storm was small and power may have been insufficient to see differences. One study found that primate infants had decreased attention spans in both the early and the mid-late gestation stress exposure groups, (37) but other studies have indicated that timing of the stress exposure on the fetus may not always be important. (34) Results of our study raise enough questions to suggest further research into pre-conception stress timing and its effect on temperament.

In summary, this study demonstrated few associations with maternal stress related to a hurricane and difficult infant temperament, but that mothers suffering from PTSD, depression, and other mental illnesses were more prone to rate their infants as difficult. Future research on major stress-inducing events should focus on the time of gestational exposure and investigations into better means of quantifying maternal stress responses. However, at the least, maternal mental health affects perception of infant temperament, which is likely to affect the quality of the maternal-infant interaction. In order to help babies born in the aftermath of disaster, the focus may need to be on the mother's mental health.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

This study was supported by NIMH grant R21 MH078185.

Dr. Harville was supported by Grant Number K12HD043451 from the National Institute of Child Health And Human Development. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institute of Child Health And Human Development or the National Institutes of Health

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Table 1

Description of study population

	Initial study population (n=365)		completed infant temperament assessment at 8 weeks (n=255)		completed infant temperament assessment at 12 months (n=171)	
	N	**%**	**N**	**%**	**N**	**%**
Age						
18–22	58	16	37	15	17	10
>22–28	116	32	77	30	50	29
>28–33	103	28	77	30	56	33
>33	88	24	64	25	48	28
Race						
white	232	65	170	67	124	73
black	114	32	74	29	41	24
other	13	4	9	4	4	2
Education						
< high school	37	10	17	7	8	5
high school diploma	79	22	54	22	28	17
some college/associate's degree	104	29	76	31	48	29
college degree	92	26	71	29	56	34
> college	43	12	31	12	24	15
Parity						
first child	151	41	105	41	64	37
has other children	214	59	150	59	107	63
Marital status						
married	214	59	167	65	119	70
living with partner	76	21	49	19	25	15
separated/divorced	11	3	8	3	5	3
never married	60	17	31	12	20	12
Income						
<$20000	88	25	53	21	30	18
$20000–$60000	164	46	118	47	83	50

	Initial study population (n=365)		completed infant temperament assessment at 8 weeks (n=255)		completed infant temperament assessment at 12 months (n=171)	
	N	**%**	**N**	**%**	**N**	**%**
>$60000	101	29	80	32	54	32
Smoked before pregnancy						
yes	55	19	46	18	27	17
no	237	81	209	82	129	83
Residence before storm						
New Orleans area	253	69	187	73	109	63
Baton Rouge area	112	31	68	27	62	36
Impact on own property and belongings						
Much/enormous	107	30	76	30	42	25
some	76	21	49	23	36	21
just a little	105	29	78	31	49	29
none	72	20	41	16	41	24
Number of indicators of hurricane experience						
0	103	28	68	27	57	34
1	126	35	94	37	60	36
2	67	19	48	19	26	15
3+	66	18	45	18	26	16

Table 2

Hurricane stressors and difficult infant temperament, Hurricane Katrina and Postpartum Mental Health Study, 2006–2008

	Temperament at 2 months				Temperament at 12 months			
	OR+	**95% CI**	**Adjusted OR++**	**95% CI**	**OR+**	**Lower 95% CI**	**Adjusted OR++**	**Lower 95% CI**
Feared for life	1.56	(0.83, 2.94)	1.75	(0.88, 3.48)	1.05	(0.46, 2.42)	0.94	(0.36, 2.46)
Illness/injury - self	0.26	(0.03, 2.01)	0.27	(0.03, 2.09)	0.44	(0.05, 3.60)	0.46	(0.05, 4.03)
Household member had illness/injury	0.76	(0.30, 1.95)	0.93	(0.35, 2.44)	0.74	(0.23, 2.36)	0.70	(0.18, 2.76)
Walked in flood waters	1.52	(0.52, 4.45)	1.82	(0.52, 6.36)	0.91	(0.19, 4.45)	1.07	(0.20, 5.76)
Floodwaters in house	0.61	(0.32, 1.15)	0.66	(0.33, 1.34)	1.18	(0.54, 2.55)	0.98	(0.39, 2.45)
Someone close died	1.22	(0.38, 3.90)	1.57	(0.47, 5.25)	1.88	(0.46, 7.72)	2.06	(0.36, 11.84)
At least some damage to property/belongings	0.76	(0.40, 1.42)	0.77	(0.38, 1.56)	1.21	(0.56, 2.63)	1.03	(0.41, 2.56)
At least some damage to others' property/belongings	0.65	(0.33, 1.28)	0.63	(0.30, 1.32)	0.72	(0.31, 1.64)	0.50	(0.18, 1.43)
Living conditions after hurricane compared to before hurricane								
Better vs. same	0.98	(0.46, 2.07)	1.12	(0.49, 2.57)	2.06	(0.79, 5.38)	3.23	(0.94, 11.10)
same	1.00		1.00		1.00		1.00	
Worse vs. same	1.69	(0.73, 3.93)	2.02	(0.80, 5.07)	0.78	(0.21, 2.93)	1.44	(0.33, 6.36)
Living conditions during evacuation compared to before hurricane (first place)								
Better vs. same	0.58	(0.25, 1.37)	0.49	(0.20, 1.22)	0.68	(0.22, 2.14)	0.46	(0.14, 1.48)
same	1.00		1.00		1.00		1.00	
Worse vs. same	0.79	(0.25, 2.47)	0.93	(0.28, 3.15)	0.69	(0.15, 3.11)	0.82	(0.16, 4.22)
Living conditions during evacuation compared to before hurricane (second place)								
Better vs. same	1.66	(0.47, 5.87)	1.22	(0.33, 4.54)	0.64	(0.16, 2.58)	0.61	(0.11, 3.56)
same	1.00		1.00		1.00		1.00	
Worse vs. same	4.10	(0.95, 17.67)	4.14	(0.88, 19.46)	1.06	(0.19, 6.03)	1.82	(0.22, 15.00)
Time away from home								
None	1.00		1.00		1.00		1.00	
<1 month	0.79	(0.34–1.82)	0.84	(0.32–2.22)	2.20	(0.74–6.53)	2.00	(0.57–6.99)
1 month-5 months	0.56	(0.23–1.37)	0.67	(0.23–1.94)	1.10	(0.32–3.77)	0.92	(0.21–3.94)
6 months+	0.60	(0.21–1.71)	0.76	(0.23–2.54)	1.73	(0.49–6.07)	1.46	(0.34–6.25)

*Using the Early Infant and Toddler Temperament Questionnaires, defined as being in the top quartile of the study population for at least 3 characteristics (activity, approach, adaptability, mood, intensity)

+ adjusted for baby's age

++ adjusted for baby's age, mother's age, marital status, income level, smoking 3 months prior to pregnancy, and parity

Table 3

Psychosocial variables and difficult infant temperament, Hurricane Katrina and Postpartum Mental Health Study, 2006–2008

	Temperament at 2 months				Temperament at 12 months			
	OR+	**95% CI**	**Adjusted OR++**	**95% CI**	**OR+**	**95% CI**	**Adjusted OR++**	**95% CI**
2 months								
PTSD symptoms	2.23	(0.97, 5.14)	2.19	(0.89, 5.44)	2.27	(0.87, 5.93)	1.82	(0.61, 5.41)
Postpartum depression symptoms	2.81	(1.37, 5.74)	3.05	(1.41, 6.63)	3.16	(1.35, 7.39)	3.16	(1.22, 8.20)
Somatization symptoms	0.73	(0.16, 3.39)	0.70	(0.14, 3.50)	0.37	(0.05, 3.06)	0.28	(0.03, 2.98)
Obsessive-compulsive symptoms	1.57	(0.78, 3.17)	1.50	(0.71, 3.17)	2.35	(1.01, 5.44)	2.09	(0.78, 5.57)
Hostility symptoms	1.78	(0.86, 3.70)	1.83	(0.84, 3.98)	2.78	(1.18, 6.51)	2.17	(0.81, 5.82)
Anxiety symptoms	1.60	(0.59, 4.36)	1.38	(0.47, 4.03)	1.68	(0.58, 4.86)	1.24	(0.36, 4.28)
12 months								
PTSD symptoms					3.42	(1.45, 8.08)	2.42	(0.85, 6.90)
Postpartum depression symptoms					2.89	(1.31, 6.40)	2.17	(0.85, 5.53)
Somatization symptoms					4.37	(1.91, 10.02)	3.22	(1.19, 8.69)
Obsessive-compulsive symptoms					3.28	(1.45, 7.42)	2.85	(1.09, 7.44)
Hostility symptoms					2.89	(1.28, 6.52)	2.54	(0.97, 6.68)
Anxiety symptoms					3.67	(1.58, 8.55)	2.58	(0.84, 7.97)

* Using the Early Infant and Toddler Temperament Questionnaires, defined as being in the top quartile of the study population for at least 3 characteristics (activity, approach, adaptability, mood, intensity)

+ adjusted for baby's age in months

++ adjusted for baby's age, mother's age, marital status, income level, smoking 3 months prior to pregnancy, and parity