Maternal Self-Efficacy Reduces the Impact of Prenatal Stress on Infant's Crying Behavior

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Objective To determine whether prenatal stress is associated with behavioral and emotional regulation problems (crying/fussing) in infants, after controlling for confounding factors. Furthermore, the study investigated the stress-buffering effect of maternal self-efficacy.

Study design Data were collected in 120 pregnant women (29 ± 3.2 weeks gestation) and their infants at 6 weeks of age. Expecting mothers completed a structured interview and self-report questionnaires on prenatal stress and self-efficacy. Crying/fussing data were obtained with a validated parental diary.

Results After controlling for confounding variables, multiple regression analyses show that prenatal stress and self-efficacy accounted for 20% of the variance of infant's fussing and crying behavior. Results suggest a mediating role of self-efficacy. Babies of mothers reporting high levels of prenatal stress cried less when their mother had high levels of self-efficacy compared with mothers with low self-efficacy. In addition, mothers of infants with excessive crying reported more symptoms of stress, depression, and anxiety in pregnancy.

Conclusion To foster the development of well-adapted parent-infant relationships and potentially to reduce infant crying in the early postpartum phase, health care professionals need special education about the effects of prenatal stress and interventions that promote self-efficacy. *(J Pediatr 2012;161:104-9)*.

Unexplained crying in early infancy is a major stress and common to many parents. In Western Europe, estimates of infants exhibiting excessive crying range from 5% to 29%, depending on the study population.[1] Infant crying also has been linked to prenatal, perinatal, and/or postnatal stress and complications during childbirth.[2-5] Numerous animal studies suggest that repeated stress during pregnancy may produce long-term biologic and behavioral disorders in the offspring. For example, prenatal stress has been found to provoke structural changes in the hippocampus of juvenile rhesus monkeys.[6] Besides the hypothalamic-pituitary-adrenal-axis, other neurotransmitter systems may be modified in offspring of stress-exposed rat mothers: norepinephrine,[7] dopamine,[8] acetylcholine,[9] and serotonin.[10] These neuro-endocrine variations may result in increased stress vulnerability and enhanced emotional reactivity. In contrast to the well-controlled animal studies, prospective human studies are sparse.[11] Prenatal stress predicts restless/disruptive temperament, more behavioral problems, and more externalizing behavioral problems in 2-year-old children,[12] and perceived stress was associated with difficult behavior in 3-month-old infants.[13] There are a few prospective studies on infant crying focusing on psychosocial risk factors in the expecting mother.[4,5,14] However, studies considering maternal resource factors such as self-efficacy are sparse. Self-efficacy is defined as a person's beliefs about his/her own capabilities to perform in a certain manner to attain personal goals[15]; such expectation influences how one feels, thinks, or behaves. Thus, sufficient self-efficacy might play an important role in protecting mothers against heightened stress during the transition to motherhood.

We hypothesized that prenatal stress could impact behavioral and emotional regulation problems (crying/fussing) in infants. We also investigated whether maternal personality resources (self-efficacy) could buffer the effect of stress during pregnancy with positive effects on behavioral and emotional regulation in 6-week-old babies. In a final step, we investigated whether mothers of infants who meet the modified Wessel criteria[16] showed more symptoms of anxiety and depression in pregnancy to help explain findings.

Methods

The study protocol was approved by the ethics committee of Basel and is consistent with the revised Helsinki Declaration of 1975. Expectant mothers were recruited from birth preparation classes (n = 163). After giving informed consent, a structured interview on sociodemographic information was conducted by trained research assistants. Questionnaires on stress and self-efficacy were provided to the participants in their third trimester (29 ± 3.2 weeks gestation) in a single session. Six weeks after giving birth, mothers were asked to complete a 3-day behavior diary to obtain amounts of

DASS-21	Depression Anxiety Stress Scales
FKK	Competence and Control Questionnaire

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Supported by a grant of the "Freiwillige Akademische Gesellschaft Basel." The authors declare no conflicts of interest.

 10.1016/j.jpeds.2011.12.044

infant fussing and crying. Subjects were included when they could communicate in German, were 18 to 40 years of age, and had filled out the questionnaires and the diaries (3 days) completely. Women were excluded when the birth weight of their child was ≤2500 g, when the gestational age of their child was ≤37 weeks, or both. Consequently, data from 120 women were available for this study. Comparisons between the final sample and the 43 excluded women indicated no significant differences in the two groups on demographic variables or prenatal variables.

A structured interview inquired about sociodemographic and medical circumstances. Women were asked to recall the amount and frequency of cigarettes smoked per day and alcoholic drinks consumed per week. The use of tobacco and alcohol were coded dichotomously (smoking: none versus one or more cigarettes per day; drinking: none versus one or more than one alcoholic beverage per week). Prenatal, perinatal, and postnatal complications and birth characteristics were extracted from medical records.

Prenatal Stress

To assess frequency and severity of maternal stress during pregnancy, we used the short version of the Depression, Anxiety and Stress Scale (DASS-21; German version: 17). The DASS-21 measures the total amount of prenatal stress along the axes of depression, anxiety (symptoms of psychological arousal), and stress (the more cognitive, subjective symptoms of anxiety). The 21-item version was developed by selecting the highest loading items from each scale of the original 42-item version of the DASS, while also aiming to retain coverage of the full symptom content of each of the 3 affective states.[18] The questionnaire holds good convergent and discriminant validity and high internal consistency ($\alpha = .77$ - $\alpha = .88$) in clinical and in non-clinical samples.[17] Examples of the 21 items are: "I found it difficult to relax" and "I felt that I was using a lot of energy." Ratings are made on a 4-point rating-scale (0 = never, 3 = very often). Scores of the DASS-21 range from 0 to 63, with higher scores indicating more symptoms of prenatal stress.

Maternal Self-Efficacy

Self-efficacy was assessed with the subscale "self-efficacy" of the Competence and Control Questionnaire (FKK).[19] The 16-item subscale "self-efficacy" ranked on a 6-point scale (1 = fully disagree, 6 = fully agree), with scores ranging from 16 to 96 (higher values indicating a greater expressiveness of self-efficacy). The questionnaire exhibits good reliability and good construct, internal, and convergent validity.[19]

Infant Fussing and Crying

A German adaptation of Barr's[20] standardized 24-hour behavior diary was used to obtain amounts of infant fussing, crying, and unsoothable crying (cry bouts that are difficult or impossible to soothe) at 6 weeks of age. Infant's behaviors were defined on the diary as exclusive and comprehensive. The recorded intervals had an accuracy of 15 minutes and represented 4 6-hour periods: morning (6 am to noon), afternoon (noon to 6 pm), evening (6 pm to midnight), and night (midnight to 6 am). Barr's[20] behavior diary is widely used in the international literature and has been validated against audio-recordings with satisfactory results.[21,22] Because fussing, crying, and unsoothable crying represent the same behavioral problem on a continuum, we calculated a crying and fussing sum score, adding the total amount of fussing, crying, and unsoothable crying.

To prove the clinical implications of our findings, we categorized fussing and crying behavior according to Wessel.[16] Because infant's behavior has been observed in a period of 3 days, infants were classified as crying excessively when they cried, fussed, or both for longer than 3 hours/day at the 3 assessment days.

Data Analysis

Data were analyzed with SPSS statistical software for Windows, release 18 (SPSS, Chicago, Illinois). Analyses were performed with two-sided tests, with a P value <.05 considered to be significant.

In exploratory data analyses, no problems were noted for the assumptions of normality and homogeneity of variance. Different statistical models were used to assess our research questions. The first approach was to determine the impact of prenatal stress on infant fussing and crying behavior. For this purpose, we performed an ordinary least square regression analysis. The predictor prenatal stress, the moderator self-efficacy, and an interaction term were entered in the model for prediction of infant's behavior (sum score of fussing, crying, unsoothable crying) in a 24-hour period. Following Aiken and West[23] (see also Baron and Kenny[24]), the predictor and moderator variables were mean-centered to avoid multicollinearity between the interaction term and its constituents. The centered predictor and moderator variables were then multiplied to form the interaction term. Conducting hierarchical regression analyses, the simple effects of prenatal stress and self-efficacy and the interaction term were entered listwise. To interpret the size and direction of the interaction-effect, Aiken and West[23] recommended plotting regression slopes by identifying predicted points in Y at levels of X and Z. Therefore, we computed the predicted values for infant's fussing and crying in points 1 SD greater than and less than the mean of prenatal stress at points 1 SD greater than and less than the mean of self-efficacy. Lines connecting these points indicate the conditional slopes relating fussing and crying and prenatal stress conditional on self-efficacy.

To test the hypothesis that mothers of infants who do or do not meet the modified Wessel criteria showed more symptoms of stress, anxiety, and depression in pregnancy, the fussing and crying classification (excessive crying versus normal) was used as a between-group factor predicting stress, anxiety, and depressive symptoms (subscales of the DASS-21) in an independent samples t test.

To give further information on the clinical relevance of the found relation between prenatal stress and infant crying, effect sizes (Cohen d) are presented.

From literature, we know a number of potential risk factors for excessive crying. They include maternal age, socioeconomic status, parity, cigarette smoking and alcohol consumption, birth weight and gestational age, mode of delivery, and infant's sex.[2,4,25-28] These variables were taken in account as potential moderators in exploratory statistical analyses with bivariate correlation analyses.

Results

Demographic characteristics of the sample (n = 120) are displayed in the Table. Mothers had a mean age of 32.12 years (SD, 3.6 years) and were predominantly Swiss (73.3%). A total of 19.2% of mothers were German, 5.8% were from the European Union, and 1.7% were from countries outside of Europe. Most of the participants were married (80.0%) and highly educated; 53.3% had a university degree.

The effects of demographic variables (maternal age, parity, family net income), lifestyle (alcohol and cigarette consumption in pregnancy), and obstetric variables (parity, gestational age, birth weight and method of delivery) on infant's fussing and crying behavior were tested. Infant's sex was significantly related to the crying and fussing sum score at 6 weeks of age ($T_{1,116} = 2.49$, $P < .05$). Boys fussed more than girls (195.08 ± 92.07 min/day versus 150.85 ± 100.50 min/day). Finding no other variable related to infant's crying behavior, only infant's sex was entered as a confounding variable in the regression model.

Table. Descriptive data of the sample (n = 120)

Variable	n (%)	Mean ± SD
Maternal age, years		32.12 ± 3.6
Highest educational degree		
Basic degree after 9 or 10 years schooling	28 (23.3%)	
Higher education entrance qualification	28 (23.3%)	
University degree	64 (53.4%)	
Net monthly income		
<$3000/month	12 (10.0%)	
$3000-7499/month	95 (79.2%)	
>$7500/month	13 (10.8%)	
Parity: Primipara	71 (59.2%)	
Smoking: yes	3 (2.5%)	
Alcohol: yes	2 (1.7%)	
Infants sex: male	66 (55.1%)	
Gestational age, weeks		39.63 ± 0.98
Method of delivery		
Vaginal delivery	88 (73.4%)	
Assisted vaginal delivery	3 (2.5%)	
Cesarean delivery	29 (24.1%)	
Birth weight, g		3422.46 ± 391.05
Fussing, min/24 hr		107.50 ± 63.10
Crying, min/24 hr		33.38 ± 31.54
Unsoothable crying, min/24 h		3.38 ± 8.12
Modified* Wessel criteria fulfilled	33 (27.5%)	
Prenatal stress†		15.93 ± 10.31
Self-efficacy‡		66.76 ± 11.00

*Crying and fussing >3 hours/day during period of assessment.
†$DASS\text{-}21_{total}$.
‡$FKK_{self\text{-}efficacy}$.

Results of the calculated ordinary least square regression model with the centered predictor variables ($DASS\text{-}21_{StressC}$, $FKK_{self\text{-}efficacyC}$, $DASS\text{-}21_{StressC} \times FKK_{self\text{-}efficacyC}$) showed that these variables accounted for 20% of the variance of infant's crying (corrected $R^2 = .207$, $F = 8.645$, $P = .000$). Results revealed that prenatal stress ($\beta = 257$, $P = .011$) and self-efficacy ($\beta = -.190$, $P = .047$) were significant predictors for the sum score of fussing, crying, and unsoothable crying. Data showed a trend for the interplay between prenatal stress and self-efficacy ($\beta = -.148$, $P = .94$). Infant's sex was included in the model as confounding variable ($\beta = -.152$, $P = .01$).

Self-efficacy seems to alleviate the effect of prenatal stress (Figure 1). Babies of mothers reporting high levels of prenatal stress cry less when their mothers have high levels of self-efficacy compared with mothers with low self-efficacy.

Maternal symptoms of stress, anxiety, and depression were significantly associated with infants classified as "excessive criers" compared with "normal criers" (Figure 2). Mothers of excessive criers reported more symptoms of stress in pregnancy ($T_{(118,1)} = 3.937$; $P < .001$, Cohen d = 0.99) and more symptoms of depression ($T_{(118,1)} = 3.083$; $P < .01$, Cohen's d = 0.85) and anxiety ($T_{(118,1)} = 2.905$; $P < .01$, Cohen's d = 0.82).

Discussion

In this prospective study, we found that at 6 weeks of age, infants of mothers reporting more emotional distress in late gestation cried and fussed more than infants of mothers with lower stress scores. We also found a trend between prenatal stress and maternal self-efficacy, indicating that maternal self-efficacy during pregnancy moderates the postpartum

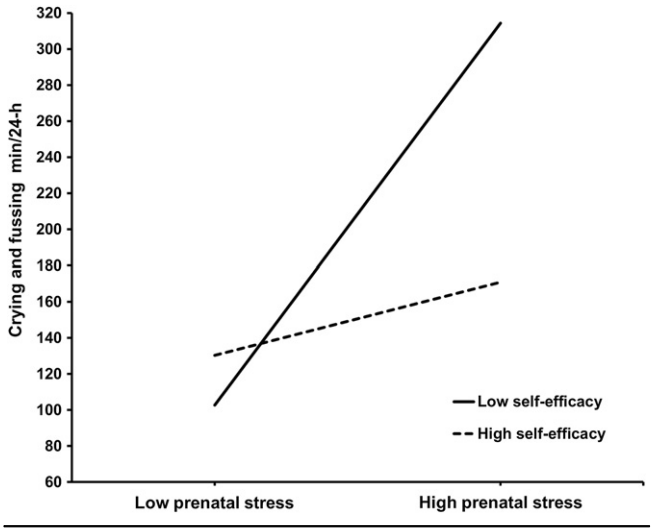

Figure 1. Regression lines of the low and high maternal stress groups showing the moderating effect of self-efficacy on the relationship between maternal stress and crying and fussing at infant age of 6 weeks.

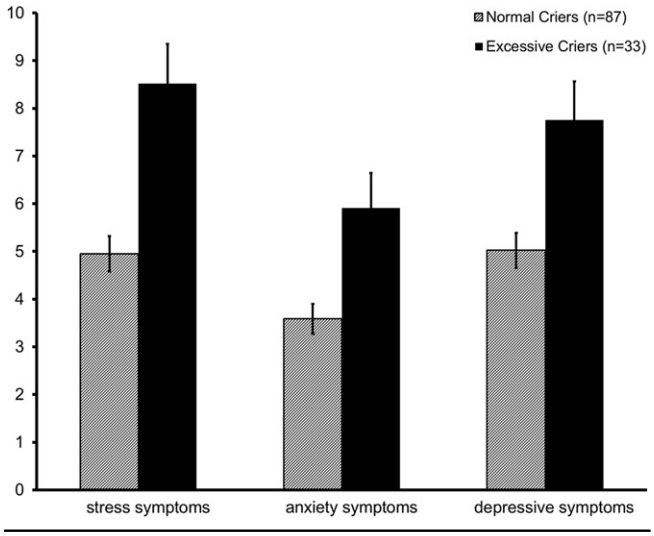

Figure 2. Subscores of the DASS-21 questionnaire for infants who do (*dark cross-hatching*) or do not (*light cross-hatching*) meet modified Wessel criteria for excessive crying. More symptoms of maternal stress, anxiety, and depression are indicated by higher scores.

effect of prenatal stress on infant's fussing and crying. Thus, maternal beliefs and attributions about the capacity to manage stressful situations with her infant seem crucial for early emotional and behavioral regulation problems in the infant.

Potential artifacts were minimized by controlling for infant's sex and other potential confounding variables considered in literature (eg, maternal age, parity, birth weight, gestational age, mode of delivery, infant's sex). Our data support the assumption that prenatal stress is associated with infant's behavioral and emotional regulation. This is in line with results from earlier studies on this topic,[4,5,14] but in contrast to the observation of other studies.[29] With a similar design and methods, Miller et al[29] found only mother's postpartum mood to be associated with longer crying/fussing duration, whereas third-trimester emotional distress was not related to infant fussing and crying nor with motor activity after controlling for potential biases. In line with other studies,[30,31] we found negative correlations between perceived stress and self-efficacy, indicating beneficial buffering effects of this resource factor about stress experienced during pregnancy. Furthermore, our results revealed a trend for an interaction effect between prenatal stress and self-efficacy, underscoring that this variable may act in a protective manner for crying and fussing at the age of 6 weeks.

We propose two mechanisms explaining our results. First, in line with Barker's "fetal origins hypothesis,"[32] a growing body of literature documents associations between stress during pregnancy and behavioral outcomes in the offspring.[12,33-35] Recent theoretical models contribute to hypotheses about the mechanisms of prenatal stress and fetal and offspring's development.[36,37] Elevated maternal cortisol in the third trimester has been associated with greater maternal report of infant negative reactivity.[38] Experimental studies with rodents have shown that high levels of stress hormones can have detrimental effects on the development of brain structures,[39,40] especially in the amygdala and hippocampal region, which might be involved in emotional and behavioral regulation. Maternal psychobiologic state can have a programming influence on the developing fetus and on infant temperament, and thus on behavioral regulation, including infant's crying behavior.

Second, we propose a social-interactive pathway to explain infant crying. According to the etiologic model proposed by Papoušek,[41,42] excessive infant crying may be the result of dysfunctional mother-infant interactions. Infant's self-regulation normally develops by the support of parents' intuitive co-regulation. Postnatal stress might interfere with the intuitive parental competencies, resulting in dysfunctional mother-infant interactions.[42] Difficult infant temperament with persistently elevated levels of crying and fussing, which might originate from prenatal stress, can compromise the mother's self-efficacy and emotional stability and affect her locus of control.

Therefore, it is reasonable to consider prenatal stress as a risk factor for infants' development. Even more, healthcare professionals in obstetrics need to be sensitized, and interventions during pregnancy should be made readily available for mothers experiencing high levels of stress during pregnancy.[43] On the basis of data from a treatment program for women with postpartum depression,[44] we propose the following practical suggestions. Healthcare workers (nurses, midwifes, obstetricians, psychologists) should ask about worries and anxieties of being a mother and give information preparing women for motherhood. In addition, maternal resources and social support should be depicted in a very specific and practical manner (eg, providing information about supporting facilities in the first few days, weeks, and months).

This study has certain limitations. We assessed maternal prenatal stress only in late pregnancy. The severity of stress, chronicity versus single stress episodes, timing of stressful events, and the effects of clustering of stressors could have impact. Following other findings[45] that third-trimester prenatal stress was associated to infant cortisol reactivity to stressful events (bathing session, vaccination, still face procedure) in a non-clinical population, we focused on this period.

Because of economic reasons, we used a standardized 24-hour behavior diary to assess crying for only 3 consecutive days. Thus, the definition of "excessive and normal criers" in this study was based on the observation of 3 days. Three days may be sufficient in accessing emotional and behavioral regulation problems in infants. However, the reliability might be even better by using a shorter observational period, because there often is resistance to completing protocols about behavior for several weeks. Generalizability of the study results is limited because our study included a selective sample of women predominantly of higher education and income.

Because findings are based on correlational data, which do not allow causal interpretations, we recommend longitudinal studies investigating the impact of prenatal stress on

behavioral and emotional problems to permit causal conclusions. ■

We would like to thank Nancy Snidman, PhD (Harvard Medical School), for revising the manuscript and Thomas Ledermann, PhD (Department of Personality and Developmental Psychology, University of Basel), for providing excellent statistical support. We are indebted to the women who participated in this study.

Submitted for publication May 23, 2011; last revision received Dec 6, 2011; accepted Dec 28, 2011.

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50 Years Ago in *The Journal of Pediatrics*

An Epidemic of Septicemia with Meningitis and Hemorrhagic Encephalitis in Premature Infants

Rance CP, Roy TE, Donohue WL, Sepp A, Elder R, Finlayson M. J Pediatr 1962;61:24-32

Reading this report of a 4-year epidemic of nosocomial *Paracolobactrum aerogenoides* infections with 11 deaths in 22 prematurely born infants in a nursery at The Hospital for Sick Children in Toronto is as frightening as any modern horror fiction. One can only empathize with the infants, parents, medical providers, and administrators who tried to figure this out, make changes, close the nursery, build a new nursery—yet cases and silent colonization of infants continued, and treatments and prophylaxis with chloramphenicol continued.

The propensity for meningitis (12 of 22 cases, 11 of whom died) was remarkable. Autopsies revealed ventriculitis with necrosis and hemorrhage, especially in the periventricular area. Nosocomial epidemics of meningitis or hemorrhagic encephalitis are distinctly unusual even in neonatal intensive care units. Investigators predicted unusual neurotropic virulence of the organism identified. They indeed confirmed that isolates were the same strain serologically and that the "epidemic" strain produced intracerebral lesions more frequently than a "non-epidemic" strain in intravascularly injected mice. We now recognize particular neurovirulence of certain bacteria (eg, *Salmonella* and *E coli* K1) and propensity to cause ischemia/infarction/microabscesses (eg, *Elizabethkingia meningoseptica* [formerly *Chryseobacterium* and *Flavobacterium meningosepticum*], *Citrobacter koseri*, *Cronobacter* [formerly *Enterobacter*] *sakazakii*) in neonates. The current name of *P aerogenoides* is *Enterobacter aerogenes*, an organism known for its nosocomial acquisition and spread, as well as virulence and multidrug resistance.

The authors suspected and had some supporting evidence that incubators were the immediate reservoir, possibly contaminated by tap water used to provide high humidity, inferior cleaning using a quarternary ammonium compound, and inadequate cleaning of nooks and crannies in incubators. Modern-day neonatal infection preventionists would have at least 20 additional possibilities on their list.

We are reminded by this report of the vulnerability of prematurely born infants, and our own modern-day horror nonfiction stories (eg, nosocomial spread of *Candida* spp, multidrug-resistant gram-negative bacilli, methicillin-resistant and -susceptible *Staphylococcus aureus*, coagulase-negative staphylococci). Interventions and devices that support their survival carry substantial risk, seemingly minor changes in medical and nonmedical care can lead to unintended consequences, and lack of key interventions such as meticulous hand hygiene and cleaning of equipment can take lives and jeopardize outcomes of survivors.

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10.1016/j.jpeds.2012.01.069