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Prenatal Material Hardships and Infant Regulatory Capacity at 10 months old in Low-Income Hispanic Mother-Infant Pairs

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Abstract

Objective—Prenatal maternal stresses have been associated with infant temperament patterns linked to later behavioral difficulties. Material hardships, defined as inability to meet basic needs, are important prenatal stressors. Our objective was to determine the associations between prenatal material hardships and infant temperament at 10 months.

Methods—This was a longitudinal study of mother-infant pairs in a randomized controlled trial of a primary care-based early obesity prevention program (Starting Early). Independent variables representing material hardship were: housing disrepair, food insecurity, difficulty paying bills and neighborhood stress (neighborhood safety). Dependent variables representing infant temperament were assessed using questions from three subscales of the Infant Behavior Questionnaire: orienting/regulatory capacity, negative affect, and surgency/extraversion. We used linear regression to investigate associations between individual and cumulative hardships and each temperament domain, adjusting for confounders, and testing for depression as a moderator.

Results—412 mother-infant pairs completed 10 month assessments. 32% reported food insecurity, 26% difficulty paying bills, 35% housing disrepair and 9% neighborhood stress. In adjusted analyses, food insecurity was associated with lower orienting/regulatory capacity scores ($B=-0.25$, 95% CI -0.47 , -0.04), as were neighborhood stress ($B=-0.50$, 95% CI -0.83 , -0.16) and experiencing 3–4 hardships (compared with none) ($B=-0.54$, 95% CI -0.83 , -0.21). For neighborhood stress, the association was stronger among infants of mothers with prenatal depressive symptoms (interaction term $p=0.06$).

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Conclusion—Prenatal material hardships were associated with lower orienting/regulatory capacity. These findings support the need for further research exploring how temperament relates to child behavior, and for policies to reduce prenatal material hardships.

Keywords

poverty; material hardships; infant temperament; self-regulation

INTRODUCTION

Poverty is associated with a variety of adverse child health outcomes, including increased risk of developmental and behavioral problems.^{1–3} Low-income families with young children face multiple stressors. Material hardships, or difficulty meeting basic needs, act as a poverty-related stressor. There is evidence that specific hardships, including food and housing insecurity and difficulty paying bills, are associated with poorer child health outcomes in low income families^{3,4}, and that these effects may occur independent of income.⁵ These stressors can cumulatively lead to toxic stress responses in children that may result in lasting physiologic and psychological dysregulation.⁶ Understanding the effects of material hardships can shed light on factors which lend particular risk for adverse outcomes and provide opportunities for intervention.

Poverty and other prenatal stressors are also associated adverse pregnancy outcomes.⁷ Understanding how exposure to prenatal hardships contributes to negative child outcomes is important. Infant temperament is one factor that may be influenced by prenatal poverty. Temperament is defined as individual differences in reactivity and self-regulation.⁸ It has been described using three broad dimensions: 1) orienting/regulation, which encompasses self-regulatory actions of focusing attention and behavioral inhibition; 2) negative affect, which encompasses negative emotions and reactivity; and 3) surgency/extraversion, which encompasses positive emotions and reactivity.^{9,10} There are standard instruments for measuring temperament in infancy and childhood, and evidence suggests that these dimensions of temperament are relatively stable from late infancy.^{9,11} Certain temperament patterns, especially those high in reactivity and low in self-regulation, have been associated with adverse developmental and mental health outcomes^{9,12}, including increased depression, anxiety, attention deficit-hyperactivity disorder, and substance use disorders.^{13,14} It is suspected that these temperament patterns contribute to vulnerability for psychological disorders, and that lower self-regulation may lead to poorer ability to buffer internalizing/externalizing emotions and behaviors.¹²

Prenatal stress, defined using standard measures of depression, perceived stress and anxiety, has been associated with temperament patterns consistent with developmental risk¹⁵, in particular, lower self-regulation and higher negative affect.¹⁶ Proposed mechanisms for this association include the possibility that stress experienced prenatally leads to changes in stress hormone levels as well as epigenetic changes which affect behavior and emotions.^{15,17} Prior studies of poverty and temperament have not examined poverty from the perspective of multiple material hardships or measured them prenatally. Studying multiple hardships simultaneously provides information about their potential differential effects. Previous

research has also not reported a measurement of temperament in infancy, which may represent an early marker of risk and an opportunity for intervention. To our knowledge, no studies have explored the association between prenatal material hardships and infant temperament. Understanding the associations between prenatal material hardships and infant temperament can provide information about early risk factors for adverse child developmental and behavioral outcomes.

We therefore sought to examine the associations between individual prenatal material hardships, namely housing disrepair, food insecurity, difficulty paying bills and neighborhood stress (worry about neighborhood safety), as well as the cumulative number of hardships experienced, and infant temperament at infant age 10 months old. We focused on low-income Hispanic mothers in a major urban center who would likely be at higher risk of these hardships. Based on previous studies showing associations between poverty, maternal depression, and child behavior, we examined prenatal depressive symptoms as moderator. We hypothesized that infants of mothers who experienced prenatal material hardships would have lower orienting/regulatory capacity and higher negative affect.

METHODS

Study Design

We conducted a longitudinal analysis of mother-infant pairs enrolled in the Starting Early Study, a randomized controlled trial of an early child obesity prevention intervention to assess the relations between prenatal material hardships and infant temperament at age 10 months old. Women were enrolled in the third trimester of pregnancy and followed until child age 3 years old. The intervention was designed specifically for low-income Hispanic families. The intervention consists of individual prenatal and post-partum nutrition and breastfeeding counseling and subsequent nutrition and parenting support groups coordinated with primary care-based well child visits. Material hardships and additional study variables were assessed at baseline during the third trimester of pregnancy. Infant temperament was assessed at infant age 10 months. This study was approved by the institutional review boards of New York University School of Medicine, Albert Einstein College of Medicine, Bellevue Hospital Center and New York City Health and Hospitals Corporation. The Starting Early trial is registered on clinicaltrials.gov (NCT1541761).

Study Sample

Study visits took place at primary care clinics at a large public hospital in a major urban center. The study included mothers who were 18 years of age or older, identified as Hispanic/Latina, were fluent in English or Spanish, had uncomplicated singleton pregnancies, and intended to receive prenatal and pediatric care at our study site. The study excluded mothers with a history of significant medical (such as sickle cell disease) or severe psychiatric illness (such as bipolar disorder or schizophrenia), homelessness, substance use, or severe fetal anomalies (such as congenital heart disease). Mothers were approached for eligibility assessment and enrollment at their routine prenatal visit between 28 and 32 weeks gestation.¹⁸ They provided written informed consent prior to enrollment. Only those who completed 10 month assessments were included in these analyses.

Assessments

We measured four material hardships, maternal depressive symptoms, and baseline socio-demographic characteristics at a prenatal visit in the third trimester. Infant temperament and a second food insecurity assessment were measured at a follow-up assessment at infant age 10 months old. Trained bilingual research staff conducted surveys in English or Spanish in person or over the telephone.

Independent Variables

Material Hardships: Housing disrepair was assessed using one question from the Survey of Income and Program Participation (SIPP): “Are any of the following conditions present in your home?”¹⁹ Responses were: 1) a leaking roof or ceiling, 2) a toilet, hot water heater or other plumbing that doesn’t work, 3) broken windows, 4) exposed electric wire, 5) rats, mice, roaches or other insects, 6) holes in floor (large enough to trip in), 7) open cracks or holes in the walls or ceiling. Mothers were classified as experiencing housing disrepair if they had any affirmative responses.

Food insecurity was measured using the US Department of Agriculture Core Food Security Module,²⁰ which consists of 10 questions assessing food insecurity over the previous 12 months. A categorical variable was created, and women were classified as “food insecure” if they reported three or more food insecure conditions. We imputed responses to missing food insecurity questions based on standard guidelines from the module.

Difficulty paying bills was assessed using two questions from the SIPP¹⁹: 1) “Have you had serious financial problems or have you been unable to pay monthly bills, rent or mortgage during the last 12 months?” and 2) “In the past 12 months, has there been a time when your household had service turned off by the gas, electric, telephone or oil company because payments were not made?” A categorical variable was created, and women were classified as having difficulty paying bills if they had an affirmative response to either question.

Neighborhood stress was assessed using questions from the Pregnancy Risk Monitoring System.²¹ We asked mothers if they did any of the following things because they felt unsafe to leave or return to the neighborhood where they live: 1) miss a doctor or other appointment, 2) go grocery or other shopping less than they normally would have, 3) stay with other family or friends. Mothers responded on a 5-point Likert scale with responses of always, fairly often, sometimes, almost never and never. A categorical variable was created, and mothers were classified as experiencing neighborhood stress if they had any response other than “never” to any of the questions.

Following from literature examining cumulative risks^{22,23}, we created a cumulative hardship variable with 4 categories: no hardships, 1 hardship, 2 hardships, and 3 or 4 hardships.

Dependent Variable—Infant temperament was measured at the 10 month visit using questions from the Infant Behavior Questionnaire – Very Short Form (IBQ-VS).^{10,11} The IBQ-VS is a parent-reported temperament questionnaire validated against the full version of the IBQ-revised, which measures temperament in three scales: orienting/regulatory capacity, negative affect and surgency/extraversion. Six questions from each subscale were chosen by

the Starting Early researchers to capture the breadth of each construct. We calculated Cronbach's alpha statistics for each subscale; alpha for orienting/regulatory capacity was 0.57, for negative affect was 0.66, and for surgency/extraversion was 0.42. Infant behavior questions were measured on a 7-point scale with the following responses: never, very rarely, less than half the time, about half the time, more than half the time, almost always and always, and responses were coded from 1–7 with never as 1. Responses to questions in each subscale were summed, and an average score was calculated. Table 1 provides the questions in each subscale.

Additional Study Variables—Maternal depressive symptoms were assessed prenatally and measured using the Patient Health Questionnaire-9²⁴, which measures symptoms on a scale of 0–27. The scale was dichotomized at recommended cut-points and a categorical variable was created with scores of 0–4 as categorized as no depressive symptoms, and scores of 5–27 as any depressive symptoms.

Maternal socio-demographic characteristics were collected at baseline, and included: marital status (single or married/living with father of baby), country of origin (US born or not), education (total years), employment status (working or not), and intervention group. Number of children was classified as first child, or one more children at home. Infant sex and birth weight were gathered from the medical record. As an indicator of household income, we measured the proportion of women receiving support from the Special Supplemental Nutrition Program for Women, Infants and Children (WIC), which has income eligibility below 200% of the Federal Poverty level.^{25,26}

Statistical Analysis

Descriptive statistics were used to describe our study population, the prevalence of prenatal material hardships, and mean temperament scores. For individual prenatal material hardships, we used Mann-Whitney tests to examine bivariate associations between each material hardship and our covariates, and each temperament domain. For cumulative hardships, we used one-way analysis of variance testing for bivariate associations between each number of cumulative hardships and each temperament domain. We then developed linear regression models to test for independent associations between material hardships and infant temperament. For each temperament subscale, we created four separate models, one with each prenatal material hardship as the independent variable of interest and the covariates described above (except for WIC receipt as there was no evidence of confounding). We also created a model for each subscale which included all four hardships simultaneously. To measure cumulative hardships, we created a linear regression models for each temperament domain using a four category hardship score as the independent variable of interest, with no hardship as the reference.²⁷ Covariates were identified a priori from literature review and included in all adjusted models.

We performed two sensitivity analyses. To compare possible effects of prenatal and postnatal food insecurity, we created a variable with four categories of food insecurity: 1) never; 2) prenatal only; 3) postnatal only; 4) both prenatal and postnatal and tested this in our significant food insecurity models. To explore effects of depression severity and timing, we

also tested moderate/severe depressive symptoms (PHQ-9 dichotomized at 10), continuous PHQ-9 score, and depressive symptoms measured at three months in all models.

Assumptions of normality and linearity were adequately met. Due to concern of heteroscedasticity, a sensitivity analysis was undertaken using logistic regression with a dichotomous temperament variable dichotomized at the top tertile, and found no differences in statistical inferences. Multicollinearity was not significant when examined using variance inflation factors and correlation matrices. We tested for moderation by prenatal depressive symptoms and intervention group in separate models using interaction terms. Significance was assessed at alpha of 0.05. Statistical analyses were performed using Stata (v 14.2, College Station, Texas).²⁸

RESULTS

Study Sample

Five hundred and sixty-six women consented to participate in the Starting Early Trial. Five hundred and fifty-nine completed baseline assessments. Four hundred and twelve out of the five hundred and sixty-six (77.3%) completed the 10 month visit. Of these, 81% were non-US born, 34% had less than high school education, 73% were married, 33% had no other children at home, and 32% had prenatal depressive symptoms (Table 2). 87.4% reported receiving WIC prenatally.

The most prevalent material hardship was housing disrepair (35%), followed by food insecurity (32%), difficulty paying bills (26%) and neighborhood stress (9%) (Table 2). Mean (SD) temperament scores for infants at 10 months were orienting/regulatory capacity 5.8 (1.0), negative affect 4.2 (1.3) and surgency/extraversion 5.7 (0.9).

In bivariate analysis, older maternal age was associated with higher orienting/regulatory capacity score ($p=0.02$), and being US born was associated with higher negative affect score ($p=0.01$). Higher maternal education was associated with higher surgency/extraversion ($p=0.02$) and negative affect scores ($p=0.008$). Male infant sex was also associated with higher surgency/extraversion ($p=0.02$). There were no other associations between maternal or infant characteristics and infant temperament, and there was no association between maternal depressive symptoms and infant temperament. There was no significant moderation by group. There were no significant differences in the prevalence of material hardships between mothers who did and did not complete 10 month assessments.

Individual Prenatal Material Hardships and Infant Temperament at 10 months old

In multivariable analyses, prenatal material hardships were associated with lower infant orienting/regulatory capacity (Table 3). After adjustment for covariates, food insecurity was independently associated with lower orienting/regulatory capacity ($B=-0.27$, $\beta=-0.12$, 95% CI -0.49 , -0.05), as was neighborhood stress ($\beta=-0.15$, $B=-0.50$, SE 0.17, 95% CI -0.84 , -0.17). In models including food insecurity measured as four categories, compared with no food insecurity, only those reporting both pre- and post-natal food insecurity had significantly lower effortful control scores ($\beta=-.17$, $B=-0.52$, SE 0.16, 95% CI -0.84 , -0.20). In a model with all four hardships entered simultaneously, only neighborhood stress

remained significantly associated with lower orienting/regulatory capacity ($\beta = -0.13$, $B = -0.47$, 95% CI $-0.83, -0.12$), and food insecurity was associated with lower negative affect ($\beta = 0.01$, $B = -0.33$, 95% CI $-0.65, -0.02$).

Depressive symptoms were not significantly associated with the outcomes in multivariable models, nor were they confounders. However, there was moderation of the association between neighborhood stress and orienting/regulatory capacity by prenatal depressive symptoms (interaction term $p = 0.06$). Among mothers reporting prenatal depressive symptoms, those experiencing neighborhood stress had infants with significantly lower orienting/regulatory capacity scores ($\beta = -0.28$, $B = -0.86$, SE 0.26, 95% CI $-1.37, -0.34$). Among mothers with no prenatal depressive symptoms, this association was not significant. There were no other significant associations between individual hardships and negative affect or surgency/extraversion.

Cumulative Prenatal Material Hardships and Infant Temperament at 10 months Old

After adjustment for covariates, mothers experiencing three or four hardships had infants with significantly lower orienting/regulatory capacity scores ($\beta = -0.17$, $B = -0.54$, SE 0.17, 95% CI $-0.87, -0.21$) (Table 4). There were no significant associations between cumulative hardships and negative affect or surgency/extraversion.

DISCUSSION

In this study of low-income, Hispanic mothers, we found that prenatal material hardships were associated with lower infant orienting/regulatory capacity scores at infant age 10 months old. Consistent with our hypothesis, we found this association with the individual hardships, food insecurity and neighborhood stress. The association between orienting/regulatory capacity and neighborhood stress was moderated by prenatal depressive symptoms. Contrary to our hypothesis, we found no association between individual hardships and other temperament domains.

We propose two potential explanations for our findings. Firstly, as source of prenatal maternal stress, material hardships may lead to structural or neuroendocrine epigenetic changes²⁹ that lead to decreased orienting/regulatory capacity. A systematic review examined studies exploring prenatal stress, anxiety, and stressful life events in relation to temperament in first two years of life. In this review, 23 out of 32 studies found associations between maternal prenatal anxiety or stress and child negative reactivity or self-regulation.¹⁶ Prenatal material hardships may create similar circumstances. Secondly, prenatal material hardships may predict changes in early parenting, or hardships may continue after birth, and lead to a home environment and caregiver practices that impact an infant's development of self-regulation. It is likely that both of these factors contribute to explaining the associations we observed.

Surprisingly, our main models did not find associations between material hardships and other temperament domains, except for a model with all four hardships entered simultaneously, where an association with small effect size between food insecurity and lower negative affect was observed. The reason behind this unexpected association is

unclear. It may be that material hardships do not influence negative affect or surgency. It has been suggested that the reactive aspects of temperament, surgency and negative affect, develop differently and at different time points than orienting/regulatory capacity, and environmental factors may have a greater opportunity to influence its development.⁹ It is also possible that mothers our study population face high levels of poverty-related stress and it may be difficult to detect small differences in effects of prenatal material hardships. More research is needed to understand the potential mechanisms of this association.

Examining individual material hardships, we found that food insecurity and neighborhood stress were independently associated with infant orienting/regulatory capacity. In models with all four hardships, only neighborhood stress showed an independent association. It is unclear why only these hardships showed independent associations. We note that food insecurity, financial difficulty and housing disrepair are stresses that occur primarily at the level of the household, while neighborhood stress may act differently as a community-level stressor. Furthermore, there is a robust body of literature demonstrating associations between food insecurity and adverse child developmental outcomes,^{2,30} and there is some evidence to support associations between neighborhood, child temperament and development.³¹ More research is needed to understand what may be unique about food insecurity and neighborhood stress as they relate to child temperament.

Our cumulative hardships model only found associations at the level of 3–4 hardships, but we note that the orienting/regulatory capacity score decreased with each additional hardship. Material hardships and poverty-related stressors tend to occur in clusters and experiencing higher numbers of material hardships has been associated with poor overall child wellness.⁴ While only two hardships were independently associated with our outcome, it is possible that the other hardships could contribute to lower orienting/regulatory capacity as well.

Our study found that the association between neighborhood stress and orienting/regulatory capacity was moderated by prenatal depressive symptoms, with lower temperament scores among infants born to mothers with neighborhood stress and depressive symptoms. Our findings are consistent with another study which found that prenatal depression moderated the association between prenatal poverty-related stress and emotional dysregulation.³² There is evidence to suggest that prenatal depressive symptoms are associated fetal neurological structural and endocrine changes that may add vulnerability for developmental and behavioral disorders.^{33,34} It is also possible that depressive symptoms affect the ways in which caregivers respond to emotional reactivity in infants. Prenatal depression was not directly associated with any of the three temperament domains; other studies which have shown mixed associations between maternal depressive symptoms and temperament.^{15,35} More research is needed to explore the potential role of maternal depressive symptoms in amplifying the developmental effects of stresses for infants.

Our study had certain limitations. Our measures of prenatal material hardships and infant temperament were by maternal self-report. Temperament is a complex construct, and generalizability is also limited by our use of selected questions from the Infant Behavior Questionnaire, which may not fully capture the range of behaviors examined in other studies of temperament. Due to our study's sample size, we may have been underpowered to detect

smaller differences in other temperament domains. Our study does not have measures of postnatal material hardships which may be meaningful confounders of the association between prenatal material hardship and infant temperament, nor does it measure hardships reported in the first or second trimester of pregnancy. Adjusting for depressive symptoms at 3 months post-partum did not change our results, though our study did not ask about depressive symptoms at the time of the temperament assessment at 10 months old. Knowledge of these factors would improve our ability to make causal inferences regarding the associations observed. Future studies should examine both pre- and post- natal hardships, and should measure these hardships earlier in pregnancy, as well as other prenatal stresses including maternal anxiety. Future studies should also assess temperament and developmental and behavioral outcomes later in childhood. Finally, our study was conducted in a low-income, Hispanic sample in New York City, and may not be generalizable to other socioeconomic, ethnic or geographic groups.

CONCLUSIONS

Our findings indicate that mothers who experienced prenatal material hardships, and in particular mothers with prenatal depressive symptoms, report lower infant orienting/regulatory capacity or self-regulation. Since temperament appears to be relatively stable after early life, and has strong associations with a variety of developmental and behavioral outcomes, understanding predictors of temperament is important to identify opportunities for intervention. Our findings address an understudied question regarding the relations between prenatal material hardships and infant temperament, and the longitudinal study design supports inferences regarding the direction of our findings. Our study adds to the evidence supporting a need for prenatal poverty screening and intervention, and suggests that interventions will likely need to integrate primary care and public health approaches in order to address the impact of material hardships on infant outcomes.

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References

1. Poverty and Child Health in the United States. *Pediatrics*. 2016; 137(4)
2. Belsky DW, Moffitt TE, Arseneault L, Melchior M, Caspi A. Context and sequelae of food insecurity in children's development. *American journal of epidemiology*. 2010; 172(7):809–818. [PubMed: 20716700]
3. Cutts DB, Meyers AF, Black MM, et al. US Housing insecurity and the health of very young children. *Am J Public Health*. 2011; 101(8):1508–1514. [PubMed: 21680929]
4. Frank DA, Casey PH, Black MM, et al. Cumulative Hardship and Wellness of Low-Income, Young Children: Multisite Surveillance Study. *Pediatrics*. 2010; 125(5):e1115–e1123. [PubMed: 20385641]

5. Gershoff ET, Aber JL, Raver CC, Lennon MC. Income is not enough: incorporating material hardship into models of income associations with parenting and child development. *Child Dev.* 2007; 78(1):70–95. [PubMed: 17328694]
6. Garner AS, Shonkoff JP. Early childhood adversity, toxic stress, and the role of the pediatrician: translating developmental science into lifelong health. *Pediatrics.* 2012; 129(1):e224–231. [PubMed: 22201148]
7. Blumenshine P, Egerter S, Barclay CJ, Cubbin C, Braveman PA. Socioeconomic disparities in adverse birth outcomes: a systematic review. *Am J Prev Med.* 2010; 39(3):263–272. [PubMed: 20709259]
8. Posner MI, Rothbart MK. *Educating the Human Brain.* Washington, DC: American Psychological Association; 2007.
9. Rothbart MK, Bates JE. Temperament. In: Damon W, Lerner RM, editors *Handbook of Child Psychology.* Vol. 3. John Wiley & Sons; 2006.
10. Putnam SP, Helbig AL, Gartstein MA, Rothbart MK, Leerkes E. Development and assessment of short and very short forms of the infant behavior questionnaire-revised. *J Pers Assess.* 2014; 96(4): 445–458. [PubMed: 24206185]
11. Gartstein MA, Rothbart MK. Studying Infant Temperament via the Revised Infant Behavior Questionnaire. *Infant Behavior and Development.* 2003; 26(1):64–86.
12. Muris P, Ollendick TH. The role of temperament in the etiology of child psychopathology. *Clinical child and family psychology review.* 2005; 8(4):271–289. [PubMed: 16362256]
13. Rettew DC, McKee L. Temperament and its role in developmental psychopathology. *Harv Rev Psychiatry.* 2005; 13(1):14–27. [PubMed: 15804931]
14. De Pauw SS, Mervielde I. Temperament, personality and developmental psychopathology: a review based on the conceptual dimensions underlying childhood traits. *Child psychiatry and human development.* 2010; 41(3):313–329. [PubMed: 20238477]
15. Monk C, Spicer J, Champagne FA. Linking prenatal maternal adversity to developmental outcomes in infants: the role of epigenetic pathways. *Development and psychopathology.* 2012; 24(4):1361–1376. [PubMed: 23062303]
16. Korja R, Nolvi S, Grant KA, McMahon C. The Relations Between Maternal Prenatal Anxiety or Stress and Child's Early Negative Reactivity or Self-Regulation: A Systematic Review. *Child psychiatry and human development.* 2017
17. Bridgett DJ, Burt NM, Edwards ES, Deater-Deckard K. Intergenerational transmission of self-regulation: A multidisciplinary review and integrative conceptual framework. *Psychol Bull.* 2015; 141(3):602–654. [PubMed: 25938878]
18. Gross RS, Mendelsohn AL, Gross MB, Scheinmann R, Messito MJ. Randomized Controlled Trial of a Primary Care-Based Child Obesity Prevention Intervention on Infant Feeding Practices. *J Pediatr.* 2016; 174:171–177. e172. [PubMed: 27113376]
19. Survey of Income and Program Participation (SIPP) 1993, Panel, Longitudinal File. US Department of Commerce BotC. Washington, DC: 1997. ICPSR Version
20. Bickel G, Nord M, Price C, Hamilton W, Cook J. United States Department of Agriculture FaNS. *Guide to Measuring Household Food Security, Revised 2000.* Alexandria, VA: 2000.
21. Shulman HB, Gilbert BC, Msphbrenda CG, Lansky A. The Pregnancy Risk Assessment Monitoring System (PRAMS): current methods and evaluation of 2001 response rates. *Public Health Rep.* 2006; 121(1):74–83. [PubMed: 16416701]
22. Gross RS, Mendelsohn AL, Gross MB, Scheinmann R, Messito MJ. Material Hardship and Internal Locus of Control Over the Prevention of Child Obesity in Low-Income Hispanic Pregnant Women. *Academic pediatrics.* 2016; 16(5):468–474. [PubMed: 26861931]
23. Frank DA, Casey PH, Black MM, et al. Cumulative hardship and wellness of low-income, young children: multisite surveillance study. *Pediatrics.* 2010; 125(5):e1115–1123. [PubMed: 20385641]
24. Kroenke K, Spitzer R, Williams J. The PHQ-9: validity of a brief depression severity measure. *J Gen Intern Med.* 2001; 16:606–613. [PubMed: 11556941]
25. [Accessed Janury 25, 2018] Women, Infants, and Children (WIC) Income Eligibility Guidelines: 2017–2018. 2016. <https://health.data.ny.gov/Health/Women-Infants-and-Children-WIC-Income-Eligibility-/6zdy-fajb>

26. Prokup JA, Andridge R, Havercamp SM, Yang EA. Health Care Disparities of Ohioans With Developmental Disabilities Across the Lifespan. *Annals of family medicine*. 2017; 15(5):471–474. [PubMed: 28893818]
27. Vittinghoff E. Regression methods in biostatistics: linear, logistic, survival, and repeated measures models. 2. New York, NY: Springer; 2012.
28. StataCorp. Stata Statistical Software: Release 14. College Station, TX: StataCorp LP; 2015.
29. Glover V. Annual Research Review: Prenatal stress and the origins of psychopathology: an evolutionary perspective. *Journal of child psychology and psychiatry, and allied disciplines*. 2011; 52(4):356–367.
30. Melchior M, Chastang JF, Falissard B, et al. Food insecurity and children's mental health: a prospective birth cohort study. *PloS one*. 2012; 7(12):e52615. [PubMed: 23300723]
31. Bush NR, Lengua LJ, Colder CR. Temperament as a moderator of the relation between neighborhood and children's adjustment. *Journal of applied developmental psychology*. 2010; 31(5):351–361. [PubMed: 20948973]
32. Barker ED. The duration and timing of maternal depression as a moderator of the relationship between dependent interpersonal stress, contextual risk and early child dysregulation. *Psychological medicine*. 2013; 43(8):1587–1596. [PubMed: 23127350]
33. O'Donnell KJ, Meaney MJ. Fetal Origins of Mental Health: The Developmental Origins of Health and Disease Hypothesis. *The American journal of psychiatry*. 2017; 174(4):319–328. [PubMed: 27838934]
34. Luecken LJ, MacKinnon DP, Jewell SL, Crnic KA, Gonzales NA. Effects of prenatal factors and temperament on infant cortisol regulation in low-income Mexican American families. *Developmental psychobiology*. 2015; 57(8):961–973. [PubMed: 26119970]
35. Lin Y, Xu J, Huang J, et al. Effects of prenatal and postnatal maternal emotional stress on toddlers' cognitive and temperamental development. *J Affect Disord*. 2017; 207:9–17. [PubMed: 27665073]

What's New

Prenatal maternal stress is associated with infant temperament patterns linked to adverse behavioral outcomes. Our study found that prenatal material hardships are associated with lower orienting/regulatory capacity in infants, with potential implications for poorer self-regulation later in life.

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Table 1

Temperament Domain Questions

Domain	Questions
Orienting/Regulatory Capacity	<ol style="list-style-type: none"> How often during the last week did the baby enjoy being read to? How often during the last week did the baby play with one toy or object for 5–10 minutes?
<i>Expression of self: regulation, focused attention</i>	<ol style="list-style-type: none"> When singing or talking to your baby, how often did s/he soothe immediately? When being held, in the last week, did your baby seem to enjoy him/herself? When showing the baby something to look at, how often did s/he soothe immediately? When patting or gently rubbing some part of the baby's body, how often did s/he soothe immediately?
Negative Affect	<ol style="list-style-type: none"> When introduced to an unfamiliar adult, how often did the baby cling to a parent? After sleeping, how often did the baby cry if someone doesn't come within a few minutes?
<i>Expression of negative emotions</i>	<ol style="list-style-type: none"> How often did the baby seem angry (crying and fussing) when you left her/him in the crib? How often during the last week did the baby protest being placed in a confining place (infant seat, play pen, car seat, etc.)? When you were busy with another activity, and your baby was not able to get your attention, how often did s/he cry? When the baby wanted something, how often did s/he become upset when s/he could not get what s/he wanted?
Surgency/Extraversion	<ol style="list-style-type: none"> When being dressed or undressed during the last week, how often did the baby squirm and/or try to roll away? When tossed around playfully how often did the baby laugh?
<i>Expression of positive affect, high activity level, impulsivity</i>	<ol style="list-style-type: none"> How often during the week did your baby move quickly toward new objects? When visiting a new place, how often did your baby get excited about exploring new surroundings? How often during the last week did the baby smile or laugh when given a toy? When placed in an infant seat or car seat, how often did the baby squirm and turn his/her body?

Table 2

Study Sample Characteristics

Characteristics	n (%)
Total	412^I
Age (mean, SD)	28.6 (5.9)
US born	
Yes	78 (18.9)
No	334 (81.1)
Years of Education (mean, SD)	10.6 (3.5)
Married/living as married	
Yes	301 (73.1)
No	111 (26.9)
Working	
Yes	101 (24.5)
No	311 (75.5)
First child	
Yes	137 (33.3)
No	275 (66.7)
Depressive symptoms	
Yes	132 (32.0)
No	278 (67.5)
Group	
Intervention	202 (49.0)
Control	210 (51.0)
Infant sex	
Male	202 (49.8)
Female	210 (50.2)
Infant birth weight in kg (mean, SD)	3.39 (0.47)
Housing disrepair	
Yes	144 (35.0)
No	268 (65.0)
Food insecurity	
Yes	130 (31.6)
No	272 (66.0)
Difficulty paying bills	
Yes	107 (26.0)
No	305 (74.0)
Neighborhood stress	
Yes	38 (9.2)
No	374 (90.8)

^IMissing: 2 birthweight, 2 depressive symptoms, 2 maternal education

Table 3

Prenatal Material Hardships and Infant Temperament: Linear Regression Models (n=404)

	Orienting/Regulatory Capacity				Negative Affect				Surgency/Extraversion			
	Unadjusted		Adjusted ^I		Unadjusted		Adjusted ^I		Unadjusted		Adjusted ^I	
	B (SE)	95% CI	B (SE)	95% CI	B (SE)	95% CI	B (SE)	95% CI	B (SE)	95% CI	B (SE)	95% CI
Hardship												
Housing Disrepair	-0.21 (0.10)	-0.41, -0.01 *	-0.19 (0.10)	-0.40, 0.02	-0.12 (0.14)	-0.39, 0.15	-0.10 (0.14)	-0.38, 0.14	-0.03 (0.09)	-0.21, 0.16	-0.02 (0.10)	-0.20, 0.17
Food Insecurity	-0.23 (0.10)	-0.43, -0.02 *	-0.25 (0.11)	-0.47, -0.04 *	-0.21 (0.14)	-0.49, 0.07	-0.25 (0.15)	-0.54, 0.04	-0.17 (0.10)	-0.36, 0.02	-0.14 (0.10)	-0.34, 0.06
Financial Difficulty	-0.05 (0.11)	-0.27, 0.17	-0.07 (0.11)	-0.30, 0.15	0.14 (0.15)	-0.16, 0.43	0.05 (0.15)	-0.25, 0.35	0.03 (0.10)	-0.17, 0.22	-0.01 (0.10)	-0.20, 0.20
Neighborhood Stress²	-0.53 (0.16)	-0.86, -0.21 *	-0.50 (0.17)	-0.83, -0.16 *	-0.04 (0.22)	-0.48, 0.41	0.02 (0.23)	-0.44, 0.47	-0.24 (0.15)	-0.54, 0.06	-0.18 (0.15)	-0.48, 0.12

* p<0.05

^I Multivariable models adjusted for: maternal age, education, marital status, immigration status, employment status, parity, presence of prenatal depression, infant sex, infant birth weight, and intervention group.

Table 4
Cumulative Prenatal Material Hardships and Infant Temperament: Linear Regression Models (n=404)

Number of Hardships ³	Orienting/Regulatory Capacity			Negative Affect			Surgency/Extraversion		
	Unadjusted	Adjusted ²		Unadjusted	Adjusted ¹		Unadjusted	Adjusted ¹	
	B (SE)	95% CI	B (SE)	95% CI	B (SE)	95% CI	B (SE)	95% CI	B (SE)
1	-0.14 (0.11)	-0.36, 0.09	-0.13 (0.12)	-0.36, 0.10	-0.14 (0.16)	-0.45, 0.17	-0.09 (0.11)	-0.30, 0.12	-0.08 (0.11)
2	-0.15 (0.14)	-0.42, 0.13	-0.19 (0.15)	-0.48, 0.10	-0.09 (0.19)	-0.47, 0.29	-0.01 (0.13)	-0.27, 0.24	-0.10 (0.13)
3 or 4	-0.56 (0.16)	-0.87, -0.24 *	-0.54 (0.17)	-0.87, -0.21 *	-0.17 (0.22)	-0.61, 0.27	-0.24 (0.15)	-0.54, 0.06	-0.19 (0.15)

* p<0.05

¹ Multivariable models adjusted for: maternal age, education, marital status, US born, employment status, parity, presence of prenatal depressive symptoms, infant sex, infant birth weight, and intervention group.

² Compared with no hardships